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RI- Research Program
General

8052

DIVISION OF WATERSHED MANAGEMENT RESEARCH

Semiannual Report

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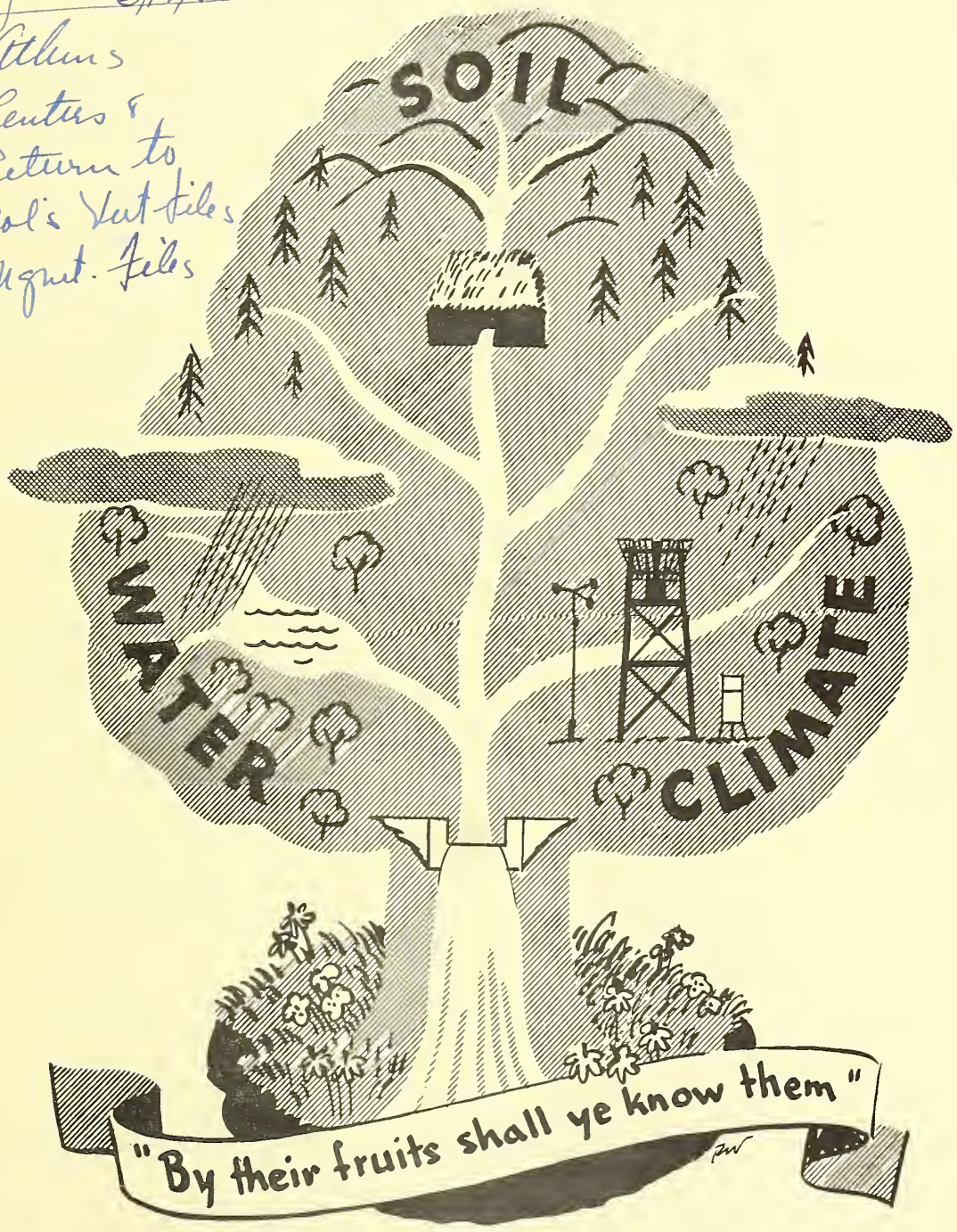

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
October - March 1955

8209-a

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SEMIANNUAL REPORT
Division of Watershed Management Research
October - March 1955

Washington Office Activities

Herb Storey spent a busy fall in the field helping Lull and others lay out the Northeastern Station's newly established Hubbard Brook Watershed Experimental Area, consulting on the Coweeta program, participating in the Consultants' meeting on the Vicksburg Infiltration Project, and representing WMR at the meetings of the Forest Research, and Soils, Water, Fertilizer Advisory Committees. In Washington, Preparations for Congressional hearings and responding to requests for information on our F. Y. '56 appropriation request occupied a good deal of his time--with most promising results.

F. Y. 1956 Program

In response to the request of the House Subcommittee on Appropriations, we have separated our appropriation increase proposal into four major headings: Integrating water and timber management; testing effectiveness of watershed improvement; control of uneconomic water-loving vegetation; and improving water yield in high snowfall areas. We have further subdivided these major divisions among the 15 experimental areas where we propose to initiate or intensify work if the $200,000 increase is approved.

Our two Research Advisory Committees have employed rather different terms to describe the projects which they recommend for expansion or initiation in fiscal years '56 and beyond. The five major divisions of our program as they are recommended in a statement received from ARS are as follows: Hydrologic response to soil cover; revegetation of silt-source areas; controlling phreatophytes; finding and adapting fire-resistant vegetation for watershed protection in mountainous areas; and analysis and interpretation of hydrologic data. The Committees rate the last-named "project" highest in priority among the five. The special importance attached to this last item by both Advisory Committees highlights their desire to see continuing tangible results from the watershed management as well as the agricultural hydrology research of the Department.

Other Research

ARS line projects: Intensified interest in the watershed protection and flood prevention program of the Department is indicated by a line project involving research on maximum discharges and other hydrologic factors from agricultural watersheds of different sizes, shapes, topography, and crop-soil complexes characteristic of the different geologic provinces of Virginia and other states. The project applies particularly to the determination of runoff rates, etc. on farmlands as a basis for designing water detention and impounding structures, and also to determine the water yield potentials of watersheds. Justification of the project is based on the fact that the watershed protection and flood prevention program has created an "enormous" demand for hydrologic information as a basis for waterway improvement and structural design. The project description also reflects the greatly increased need for water yield data from small watersheds.

(Over)

Other approved ARS line projects call for research on "the relation of climate to conserving water for crop production in moisture deficient areas," "causes of wind erosion and evaluation of practices for its control," "factors affecting soil formation and stability, and procedures for characterization of soil structure in relation to plant growth," and "soil moisture, soil temperature, and gaseous diffusion in soils; their interrelationships and biological significance."

State Agricultural Experiment Station soil-water research projects include such studies as the water requirements of the apple tree, development of land use equations for the sloping soils of Indiana, evaluation of potentially drought-resistant grasses for the Southwest, and studies of physiological factors that influence water needs and use in production of horticultural crops.

More on Radioactive Tracers: Of possible value in studying the movement of water through lysimeters and from runoff plots and watershed units is the report of a recent study of the efficiency of sand filtration as reported in Separate No. 592, ASCE Proceedings, Volume 81, January 1955 (pp. 592-1 to 592-23). The author, Donald M. Stanley, points out that little is known on the mechanism of the removal of suspended matter by rapid sand filters, and that the designs so far are based on empirical experience which does not adequately consider local conditions. The problem under investigation concerns the determination of principles of design adequate for the removal of particles according to their character and the requisite quality of the effluent. The radioisotope I^{131} was finally chosen from among others tested because it was cheap, has a short half-life, and is a good gamma ray emitter.

Separate No. 630, ASCE Proceedings, Volume 81, February 1955, contains an article entitled "Flood Frequencies Derived from River Forecasting Procedures." In developing the procedure and in illustrating the use of the curves the authors make no attempt to take into account the effects of extensive changes in land use, land practices, or both, on the predicted flood frequencies. For example, Figure 3 on page 630-11 which represents a 12-hour unit hydrograph, might assume a quite different shape where watershed improvements had been applied over a considerable portion of the watershed. It might be worthwhile bringing together and publishing in the ASCE Proceedings some of our own data on watershed experimental areas where changes in the shape of the unit hydrograph following watershed treatments have been demonstrated. Examples should be available from our research in southern California, Utah, and North Carolina, among others.

National Science Foundation: The fourth annual report of the Science Foundation Board, like the previous report, contains some excellent discussions on science policy and the relations of science and scientific workers to everyday life. You will find much interesting and provocative reading.

Subcommittee on Hydrology

The Subcommittee is still interested in hearing about research or other analytical activities of its member agencies. The series was opened by Herb Storey with an illustrated lecture on our watershed research, followed

subsequently by others from ARS, Geological Survey, Corps of Engineers, and Bureau of Reclamation. The next scheduled talk is to be given by SCS hydrologists on procedures for analyzing watershed conditions and the effects of small watershed programs. A new work group on standardization of normals, headed by Walter Langbein, has just been organized. It will delve into current procedures and the possibilities of developing standard nationwide criteria and periods for computing normals as they may apply to the analysis and reporting of basic hydrologic data. Walter Langbein is also completing his revision of the 1943 National Planning Board report on "Principal Federal Sources of Hydrologic Data." The Forest Service is among the three agencies which have satisfactorily fulfilled his request for information.

National Watershed Congress

Shortcomings of the first National Watershed Congress led Bernie Frank to make four suggestions to the General Committee in planning for the next Congress. The first proposes the appointment of a technical committee, composed of outstanding watershed researchers, to collect, interpret, and bring before the Congress the latest scientific knowledge on what watershed programs can be expected to accomplish by way of reducing erosion, sedimentation, and flood discharges. The report would provide a sound factual basis for policies and proposals of the next Congress. The second provides for creation of a Public Lands Committee to better insure thorough consideration of the role of public lands, both eastern and western, in watershed programs. The third suggestion provides for a thorough and objective discussion on the obstacles to applying and maintaining sound watershed programs on both private and public lands. This subject would also be thoroughly explored in advance by a special committee and opened up for full discussion on the floor following its report. "Final" answers might not be reached, but at least the members would all have something to ponder over after returning to their local watershed undertakings. The fourth point suggests more adequate attention to the recreational, fish and wildlife, and other "intangible" aspects of watershed planning and action programs. It proposes that the policy statement of the first National Watershed Congress be reexamined and revised to the extent necessary to recognize these values, and that strong provisions be made to safeguard or develop them in watershed programs, even if such values can't always be justified in terms of commercial benefit-cost ratios.

Following discussion of the above proposals by the General Committee, one of its members wrote, "All of your suggestions and recommendations were well received. It is believed that the Committee will be able to make use of your proposals."

Agriculture Yearbook

As was to be expected, not all the articles which prospective authors were invited to submit have been accepted by the Yearbook editor. (The decisions are his entirely, and he has not seen fit to consult Committee members about them. Similar rejections have occurred in previous years, and page 4, item 6 of the prospectus definitely implies the possibility that some contributions might be rejected this year also.) The California Station's semiannual report for this period registers a complaint to the effect that the Yearbook Committee must have been at fault in not planning

adequately, else all articles submitted would have been accepted. Since a copy of the "plan" (prospectus) was made available to each contributor well in advance, any apparent duplications or other weaknesses detected at that time should have been commented upon then, as specifically provided for on page 5, item 8, of the prospectus. If any such comments were submitted, they have not come to the Committee's attention.

The most meticulous planning cannot guarantee that all articles, however well written, will be accepted for publication in a given medium. All of us who write extensively have had our offerings rejected at one time or another despite our own high opinions of their quality and readability. Of course, opportunities for publication elsewhere can often be taken advantage of, and several authors have acted accordingly.

Miscellaneous

Photographs: The black-and-white photo file is being brought up to date, thanks to the hearty cooperation of the field. Several stations are planning to retake early photographs where circumstances permit.

Several conservation manuscripts have been reviewed and revised, including an R-9 manuscript on "Forest Watersheds" prepared for science teachers; an educational film strip on soil, water, and forest conservation, prepared by a private firm; a National Association of Manufacturers brochure on conservation; and a brochure of the Sport Fishing Institute entitled "Land, Water, and Fishing."

8209-b

RS-A1-8
SPECIAL
Biological Factors
Effect of logging on salmon streams December 21, 1950

Summary Report

Effect of Logging on Salmon Streams

From a survey of 30 logged streams
in Southeast Alaska

by

L. W. Zach

The Southeast Alaska salmon canning industry relies heavily on the pink salmon pack. Pink and chum salmon spawning occurs in the hundreds of small and medium size creeks of Southeast Alaska. Timberlands cover much of the spawning stream watersheds. Further development of Southeast Alaska depends on increasing utilization of the forest resource. This use must not harm the fishery resources. Investigations of the Alaska Forest Research Center are aimed at learning the basic characteristics that make a salmon spawning stream and the requirements for logging operations to protect those qualities. These investigations are divided into two projects. The first is a long-term study of four test streams in the Kasaan Bay region where the first pulptimber logging is expected to start. The second is an observational study, reported here, of 30 salmon streams exposed, at least in part, to logging, mostly during the past 12 years. They are largely on the Southern and Petersburg Divisions. Some of these had been the subject of much discussion as to whether or not the logging had damaged the stream for spawning. Others were merely selected as representing typical streams and logging methods. Early results from the Kasaan Bay test streams have furnished essential background for observing and evaluating the conditions found on the logged streams. Important clues to stream character are such features as flood marks, gravel size, gradient, debris jams, fish bones, pools, windthrow, channel changing, size of flow and velocity.

All National Forest timber sale contracts for areas that involve spawning streams include a standard itemized general clause giving comprehensive protection to the stream. Additional clauses are added if necessary to cover specific cases. (See appendix for general clause.)

The appendix of this report contains brief descriptions and photos of each stream examined. The report itself is a summary of findings, many of them based only on repeated observations, but which should be of value until more is known about the possible effects of logging on salmon streams.

(Over)

What makes a salmon spawning stream?

Systematic investigations and observations covering 30 logged streams plus basic detailed measurements on four unlogged streams have indicated the factors and combination of factors that make a good spawning stream. Fish and Wildlife Service officials rate spawning streams as major, minor, and "pidler" creeks. This classification and its limits have not been precisely defined but implies good big spawning streams, smaller streams of some value and the small unimportant marginal streams that may or may not acccmmodate a few spawners. The better streams have:

1. Stable flow with no destructive floods. Floods and wide flow fluctuation are very common on Southeast Alaska streams during the fall storm periods. High water is detrimental when it changes channels and spawning beds, causes spawning in channels that are normally dry, causes spawning on gravel bars that go dry, and when it leaves spawners stranded in high water channels, sloughs, potholes, or other environment unsuitable for spawning.

   Sustained winter flow is important; lowest discharge usually comes during protracted winter freezes. When gravel containing spawn freezes or dries out, the eggs are killed.

2. Favorable current with optimum velocity at about 1.8 feet per second. Acceptable limits extend from about 1.2 to 2.4 feet per second. Fluctuation in flow affects velocity; stable flow is desirable.

3. Suitable gravel which ranges from pea to egg size. With other factors favorable spawners will tolerate a considerable range in gravel size.

4. A high proportion of creek channel in riffles suitable for spawning. Spawning capacity of a stream is thought to be roughly controlled by the riffle area. Quiet pools though good for fish to hide and rest in are not used for spawning.

5. Gentle uniform gradient which causes favorable water velocities over much of the stream regimen.

6. No obstructions to spawner ascent. The pinks are the least aggressive salmon in passing obstructions. Rapids, falls, debris, log jams may impair the value of a stream for spawning.

7. Tidal zone and sea approaches not conducive to illegal and destructive fishing. Such fishing undoubtedly has made serious inroads on the escapement of parent fish.

The above characteristics promote consistent production. Factors limiting spawning, hatching and fry migration are not serious in the best streams. Such creeks should be consistent producers if not affected by factors outside the regimen of the spawning stream.

Most pink spawning streams in Southeast Alaska are far from optimum. They often lack one or more of the qualities needed. Chance then plays a larger part in successful spawning.

The factors considered most responsible for inconsistent production are:

1. Extreme variation in rainfall during the spawning season which may give anything from five inches or more a day to rainless periods of up to two weeks. On the test streams under observation this gave a maximum discharge during the spawning season of September 15 to October 15, 1949 that was 232 times as much as the minimum spawning season flow. Marked changes often occur with such extreme fluctuations. Some streams remain unseeded as a result of continued drought. Exposed redds (nests) from falling water are very common.

2. Bear and bird predation. This is very serious on some streams. Bears often kill all the spawners in small streams. This is most striking on the brook type creek. Larger streams offer more protection. Vegetative cover helps.

3. Too much gradient, resulting in high water velocity which in turn gives gravel that is too large. Many poorer spawning streams appear to be due to this chain of gradient-velocity-gravel. Fast water needs little channel for a given flow. It removes the small gravel leaving the bottom too hard and rough for good spawning.

4. Streams that are too small to give adequate minimum flows. These offer little hope for successful spawning.

Steps taken to protect spawning streams in logging:

All Forest Service timber sale contracts on areas involving salmon spawning streams include clauses to protect the fishery resources. These clauses are reviewed, revised when necessary and approved by the Fish and Wildlife Service before the contracts are completed.

A number of practices have been used to avoid damage to salmon streams. They include:

1. Prohibiting yarding or roading in a salmon stream bed. Roading across a stream is allowed only at designated crossings specifically authorized. During the "off season" which is the time of the year after the fry have left in the spring and before the spawners arrive in the late summer or fall there can be no direct damage to the fish but the precaution is exercised to avoid damage to the spawning facilities. On most salmon streams observed in 1949 and 1950 this period can safely be set for July 1 to August 15 if chum and pinks are the predominant fish. If pinks only, the early date can be advanced to June 15. On many streams spawners do not arrive before September 1. From September 15 to October 15 spawning is at its peak on the Kasaan Bay test streams. Pink fry leave earliest; the peak

migration in 1949 and 1950 was in May on Old Tom Creek. Peak chum migration was in June. Variation by years and between streams has been widely observed. Some streams are known as "early streams" others as "late streams".

Logging in the stream during its barren period is not known to do any harm provided the physical factors remain unchanged. Where logging has been directly down the stream the channel has often been straightened, deepened and cleared of debris. This can speed discharge which would improve the stream if the current had been too sluggish. It would impair the stream if the current was optimum or already too fast.

Stream crossings have far less impact on the stream. Few streams were examined that did not have substantial areas unsuited to spawning. Crossings over bed rock outcrops or coarse gravel could hardly harm the bed at any season of the year. Bringing soil, silt or debris into the stream is another matter. No quantitative or qualitative damage has been evaluated for this. In all streams examined, silt did not remain in the stream channel or on the spawning beds even during the season of logging. High water carried it out. Damage might occur from the silt during the spawning season but would probably be limited to that season only. Diversion of stream flow down logging roads can usually be avoided by crossing on proper approaches. If danger of diversion exists barriers can be thrown up. With firm banks and a hard bottom, limited stream crossings should do little harm at any season of the year.

2. Leaving a 100-foot reserve strip of timber along the creek to avoid disturbance to the stream. This is a conservative measure that sometimes backfires through excessive windthrow when cutting exposes the strip to the wind. Another common occurrence on the streams of gravel-fill valleys is natural channel-changing and bank cutting. Windfalls result. These sometimes effectively collect debris to form extensive jams. Logging them eliminates this threat and saves the timber. If done properly, in the "off season", no damage occurs. It appears that such logging practice should be more common. In addition, sound natural windfalls should be removed and utilized.

3. Requiring all trees to be felled away from the creek. This is unrealistic and practically impossible. The result is the heavy leaners must be left to fall across the stream at a later date. A better approach for trees leaning over the creek is to fall them directly across, pull the logs, remove small debris and drag the top well back from the stream. Where the top goes well beyond the far bank it can be left as it is usually well anchored. This work again must be planned for the "off season". Tractor logging is flexible and well adapted to working along streams.

4. Falling all trees within 100 feet of the creek whether merchantable or not to avoid windfall. This is a reversal of the 100 foot reserve strip method. It imposes an unproductive task on the logger and can defeat its purpose if material falls into the creek or can be washed in. Trees along a creek channel naturally lean over the creek. If they are not removed after falling they may as well be left standing. This stipulation should be made with flexible application to suit conditions obtaining. No sale has yet been observed where this clause has been literally applied.

5. Prohibiting the use of stream gravel for road building. This sometimes appears to be an unnecessary precaution. It is realized that any interference with natural stream conditions is looked on with suspicion at this stage of the game. It is also appreciated that investigations have not gone far enough to give all the answers. But it does appear, from our examination of many salmon streams, that conservative use of flood-formed high gravel bars would have little or no effect on the stream.

   Some streams have millions of yards of gravel. Our examinations indicate that thousands of yards are shifted and reshifted from bar to bar. This is a natural occurrence. The removal of a few hundred yards under proper supervision probably would have no measurable effect on the stream.

   The use of gravel bars for truck and tractor roads has sometimes been permitted. This depends again on conditions surrounding the individual stream. Changes with every flood, repeated crossings required, unpredictable soft spots and the responsibility of keeping the stream clear should make such practices of questionable value to the practical logger.

6. Bridging of streams which has usually been required on larger streams. Permanent or semi-permanent bridges are expensive. Typical streams with unstable banks and recurring floods make bridges a very expensive problem. The Tunahean Creek bridge (Fig. 103, Appendix)* has been a recurring source of expense. General rules cannot be made but in many cases fording at selected spots seems feasible. Temporary low water bridges (Fig. 105, Appendix)* can often be used to avoid direct use of the creek. Truck hauling across a creek at a ford does not drag material into the creek as does donkey swinging or tractor roading.

7. No disturbance of the stream bed in the tidal zone. Booming in the tidal zone of streams was common practice a few years ago. It was mistakenly thought that no harm could be done to a stream below the high tide point. Tidal zone spawning is important on most pink streams and fry emergence in that zone has been established. It is now felt that activity in the tidal zone channel should be avoided except during the "off season". Work on other portions of the beaches should not affect the spawning stream.

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*Not included.

Summary and Conclusions

1. Few of the 30 streams examined showed any recognizable damage from logging and some of these operations took no precautions to protect the streams. As a result of these examinations it would seem that logging could be carried on in the watersheds of most salmon streams if proper safeguards are employed. The characteristics of the drainage and stream should be understood to allow intelligent planning for the operation.

2. No evidence was found that logging had destroyed fish runs in any of the streams examined. Some streams have been noticeably cleared of accumulated windfalls and associated debris by logging downstream. All streams that accommodated fish before logging still support spawning. Stocking appears to fluctuate in the same manner and to the same relative degree as in adjacent unlogged streams.

3. Logging has been done on only a few of the thousands of pink spawning streams. Timber suitable for the lumber industry normally occurs in limited blocks on small areas. Few watersheds have more than a small fraction of their total area occupied by operable saw timber. A compilation of the watershed area compared to area cleared by cutting on the 30 streams examined showed 127,200 acres of watersheds with 1550 acres cleared or mostly cleared by saw timber cutting. Thus, only 1.2 percent of the watersheds was cleared. The largest clear-cutting of the 30 areas examined covered 15.5 percent of the watershed. Proposed pulptimber cuttings will cover greater proportions of some watersheds. Comprehensive cruises of Harris and Maybeso Creek valleys found 5000 acres of the total 19,200 acres of the Harris River watershed and 2004 acres of the total 9280 acres of the Maybeso Creek watershed suitable for pulp timber. The rest consists of scrub, muskeg and inoperable areas. Harris and Maybeso Creek valleys contain substantially better than average stands. Hence most watersheds will be less completely cutover.

   Past logging along or near spawning streams was confined to the best timber of the lower valleys. A very small proportion of any of the major streams' watersheds has been touched by logging. In no case have sale areas exceeded a few hundred acres. With tractor yarding so much residual non-sawtimber hemlock may be left that cutting is not discernible on aerial photographs.

4. Many Southeast Alaska spawning streams are characterized by such unfavorable conditions as wide fluctuation in flow, winter freezing, droughts, heavy predation and small size. Together these result in uncertain production and a heavy loss of spawners. Streams that are too small cannot be expected to produce fry. Ordinarily watersheds of less than about one square mile were found too small to feed even a minor spawning stream.

5. Observations show striking variations from stream to stream. Blanket rules to protect the fishery resource in all cases would have to be so stringent that they would needlessly obstruct operations in many cases. Logging methods must be planned to meet the protection requirements of the individual stream. Thus the salmon resource can be protected without unnecessary burdens on the logging operation.

8209-c

TECHNICAL NOTES
of the
ALASKA FOREST RESEARCH CENTER

No. 4 Juneau, Alaska

Effect of Rainfall on Stream Flow in Southeast Alaska

Waterflow patterns of Southeast Alaska salmon streams are characterized by marked fluctuation in flow and recurring fall floods. A low stage in the dead of winter while precipitation is stored as snow, a considerable spring run-off that is quite stable until the snow is dissipated, and summer and fall flows fluctuating with rainfall seems to be the typical pattern. Extreme low water follows rainless periods in summer. On streams having no lakes to exert a stabilizing influence, the sustained heavy rainfalls of autumn cause violent floods.

First year measurements on 4 streams, taken in a study of the effect of logging on salmon spawning streams, indicate also that in this region of heavy rainfall watersheds remain almost continually saturated. Because of this the watersheds have little extra storage capacity during the seasons of heaviest rainfall, hence fall floods are normal. Total rainfall on the watersheds of streams without sizable lakes drains out within a few hours after it falls.

The watersheds are composed primarily of thin soils over bed rock on steep slopes and water-logged raw peat in the muskegs. Ground storage capacity of water is small. Base flow is a small fraction of the discharge rate accompanying heavy rains. With ground storage capacity quickly exhausted after rains commence, discharge quickly rises to roughly equal the rainfall rate. On Harris River the September 21-22 precipitation of 7.13 inches resulted in a discharge rate equal to the rainfall rate before half the rain had fallen. After two days of diminishing rain followed by two rainless days discharge had decreased from the peak of 4230 second-feet to 140 second-feet. When the small soil water storage capacity is exhausted stream flow is very sensitive and closely correlated to rainfall. Figure 1[1/] and Table 1 clearly show the impact of the 4.98-inch rainfall of October 13 on the saturated watershed of Harris River. Here the preceding 5 days of October 8 to 12 yielded from 1.62 to .22 inches of rain keeping the soil saturated and the stream level above normal and fluctuating rapidly. The October 13 rainfall drove the river's discharge rate to the season's peak of 7360 second-feet. The next day this was down to 715 second-feet falling to 280 on the 15th and 150 second-feet on the 17th of October.

Rainfall in Southeast Alaska is not of the cloudburst type and thunderstorms are uncommon. The heaviest rainfalls of the past year were steady prolonged downpours characteristic of the fall southeastern storms.

1/ Not included.

(Over)

Table 1 gives comparative data between rainfall and discharge during the peak salmon spawning period for two of the four streams under observation. The Table 1 values giving greater discharge than total precipitation is probably due to heavier rainfall at higher elevations. Flow patterns for the three streams without lakes are nearly identical. The fall rainy season normally produces the most violent floods at which time movement of log jams and gravel bars and minor changing of stream channels is common. Water erosion is not serious outside of the stream beds although landslides do occur on these forested watersheds when the saturated thin soil over bed rock slides from steep slopes. Such slides are seldom extensive, the most common being a narrow ribbon from near the top of a ridge and ending at the beach or intervening bench.

Table 1.

	Maybeso Creek	Harris River
Length of drainage	6 miles	11 miles
Area of watershed	14.5 sq. miles	30 sq. miles
Minimum discharge	15 cu. ft./sec.	42 cu. ft./sec.
Maximum discharge	3460 " " " "	7360 " " " "
Aver. max. 24 hr. rainfall in cu. ft./sec. 1/	2000 " " " "	4040 " " " "
Aver. max. 48 hr. rainfall in cu. ft./sec. 2/	1400 " " " "	2900 " " " "
Aver. max. 24 hr. discharge	2032 " " " "	4542 " " " "
Aver. max. 48 hr. discharge	1345 " " " "	2710 " " " "
Ratio minimum to maximum discharge	1/231	1/175

1/ Average of maximum 24 hour period precipitation recorded on October 13, 1949.

2/ Average of maximum 48 hour period precipitation recorded on September 21 and 22, 1949.

April, 1950 L. W. Zach

SEMIANNUAL REPORT -- OCTOBER 1954 THROUGH MARCH 1955

Division of Watershed Management Research

California Forest and Range Experiment Station

GENERAL

The Yearbook Hassle

As reported in the last semiannual report, three members of the California Station accepted invitations to work on chapters for the USDA Yearbook, "Water". Colman was to work on two chapters, Gleason and Sinclair each on one. Latest word from the Yearbook editor is that two of the four chapters were accepted, and the others rejected politely, but firmly.

This is not a good record. Something went wrong between here and Washington, and resulted in a most unfortunate waste of time and effort. The fault did not lie in the manuscripts that were prepared. All were carefully written, reviewed, and revised. All stood well on their own feet and supplied good discussions of the subjects assigned. All were sound technically and written well. But the criticism received from the editor was that each one rejected duplicated the subject matter of chapters prepared by others. It looks to us as if the original planning, as represented by the Yearbook prospectus, was to blame. Perhaps there were too many cooks at this stage.

We regret the lost time, and the disappointment of authors who did their best and were turned down through no fault of theirs. In the future when nation-wide participation is required in publications, meetings, or other programs, we hope planning will be adequate to avoid such things.

Snow Again

California's mountains are a little shy of snow this year, but California has not been shy of talk about snow research. Director Jemison, Colman, and Anderson have sung for their dinners and trod the boards in several parts of the state discussing research in snowpack management. (See Meetings.) The State Chamber of Commerce has shown particular interest, inviting Jemison and Colman to talk about snow at three of this spring's regional meetings of the Chamber. Colman and Anderson took part in a symposium on snow at the Pacific Southwest Meeting of the American Geophysical Union. A proposal for snow management research made at the A.G.U. meeting aroused a good deal of interest in the newspapers, partly perhaps because of the name "Operation Wet Blanket" given to the research program. The San Francisco Chronicle carried the story on the first page, and even the New York Times gave it prominent space. Probably an eye-catching name would help generate interest in other research in watershed management.

Publications "Sold Out"

"A Guide to Erosion Reduction on National Forest Timber Sale Areas", co-authored by Kraebel, has been a best seller. The Regional Office, publisher of the Guide, reports that the first printing of 1,000 copies is exhausted, but that requests continue to arrive. Plans are being made to re-print the Guide and, we hope, make a few editorial changes which seem to be needed.

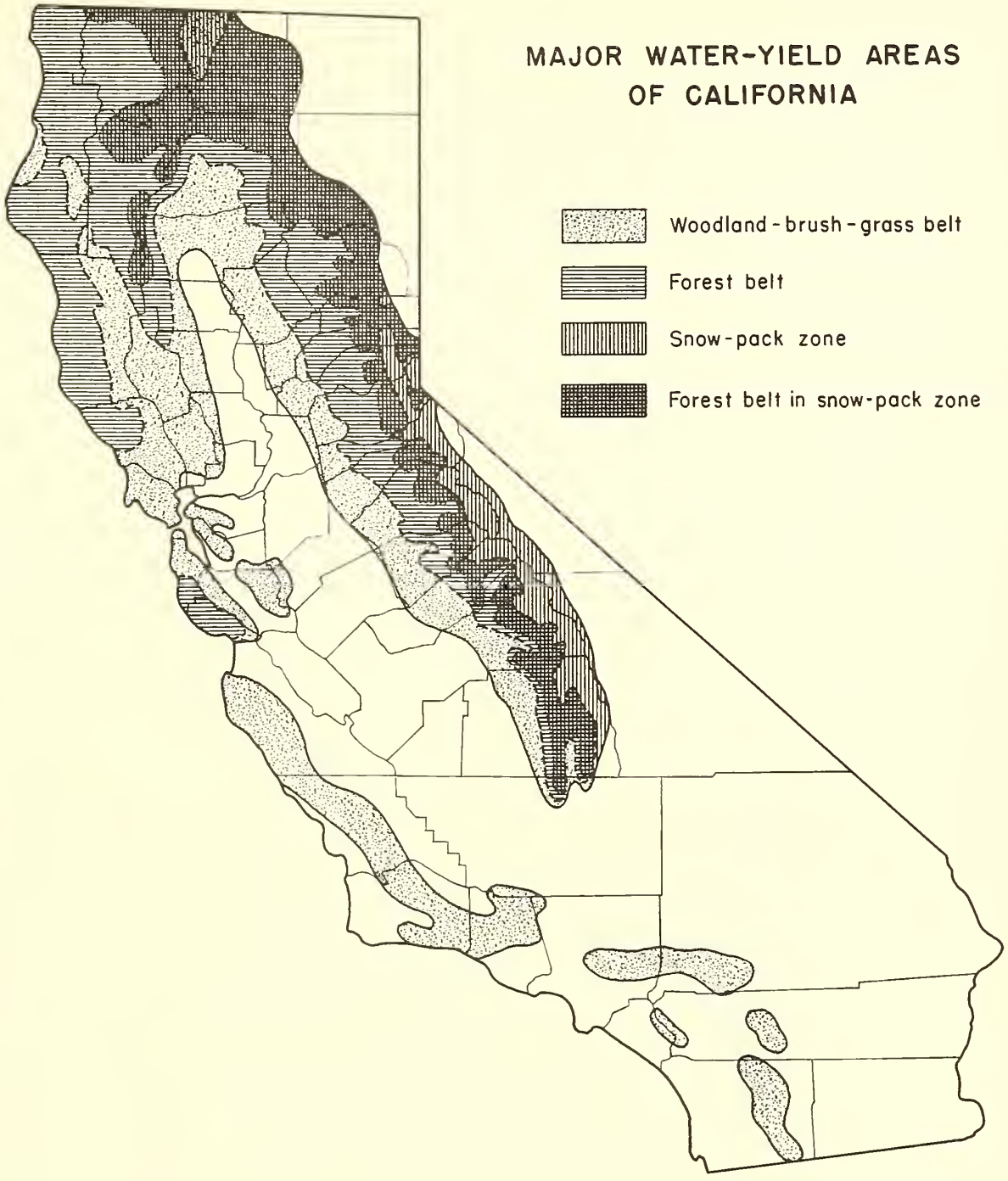
Hamilton's Technical Bulletin, "Rainfall Sampling on Rugged Terrain", is also reported sold out. With the first printing of 3,000 copies gone, and back-orders for 1,000 on hand, a re-printing job is in the offing.

"Lands of Origin"

California is engaged in a controversy over who has rights to the use of water, the "counties of origin" of the water, or the counties to which this water is transported for use. We have recently delineated the lands of origin of California's water. This was done to define more clearly where most of the State's annual supply of streamflow comes from. A copy of the resulting map is inserted in this report and shows that 42 percent of California's land yields 95 percent of California's average annual streamflow. The map further divides this main water-yielding area into belts which have significantly different implications for watershed management.

A 3-1/2 by 4-foot copy of the map has been prepared with removable overlays of colored transparent Plexiglas. Its construction may be of interest to our colleagues. A yellow sheet is placed first to cover the entire water-yielding area. Over this is placed a red sheet which covers the entire snow-pack area. Then a blue sheet is placed, which covers the entire commercial forest belt. A touch of "magic" enters when the blue sheet is placed, because the forest area below the snowpack line suddenly becomes green, while that above becomes purple. Thus, the forest belt is divided strikingly at the lower edge of the snowpack zone. The overlays are held in place by pegs that protrude from the map board and engage holes drilled through the Plexiglas. In case you get ideas along this line, beware of plastic pegs, as they shear too easily; use birch dowels instead.

We have had considerable success in explaining watershed management problems by using this map. The build-up of colors holds the attention of the audience, and the separations on the completed map make areas of different kinds of management clear. We have found that it comes as rather a shock to audiences to realize that their water comes initially from the land, and from a relatively small part of the State's area--rather than from reservoirs and wells.



	Area (Acres)	Av. ann. water yield (Acre feet)
Woodland-brush-grass	17,850,000	8,930,000
Forest belt below snow zone	12,530,000	22,550,000
Forest belt in snow zone	9,070,000	27,200,000
Alpine snow zone	3,000,000	9,000,000
Total	42,450,000	67,680,000
Entire State	101,300,000	71,000,000

Soil Water Gadget

Our colleagues may be interested in a few statistics about the Fiberglas soil moisture instrument, which has been under commercial manufacture for about seven years. Sales have been increasing progressively since the start of manufacture. In 1950, 1,200 soil units were sold; in 1951, 2,000; in 1952, 3,000; in 1953, 2,000, and last year sales ran to 4,000 units. Total sales stood at 14,921 soil units and 260 meters at the end of February 1955.

Most sales have been made to organizations in the United States proper. Our next best customers are in Canada, where 670 soil units have been purchased. Inquiries about the instrument have come from 7 countries in Africa, 14 in Europe, 10 in Central and South America, and 6 in Australia and Asia.

PERSONNEL

Everett L. Hamilton has been appointed to the International Committee on Precipitation of the International Union of Geodesy and Geophysics. Other members of the committee include L. Serra (France), L. Poncelet (Belgium), and Max Kohler (U.S.A.).

Henry Hellmers has been designated as co-chairman of the program committee for the Ecological Society meetings to be held in Pasadena in June 1955, in conjunction with the A.A.A.S. Pacific Division meetings.

PUBLICATIONS

Manuscripts Published

"Water Control and Timber Management," by E. A. Colman. Proceedings 45th Annual Western Forestry Conference: pp 24, 25: 1954. Explains the three objectives of watershed management as protection of the land, repair of watershed damages, and improvement of water yield. Further explains how forest lands can be managed for water yield control in the course of timber production.

"A Guide to Erosion Reduction on National Forest Timber Sale Areas," by C. J. Kraebel and members of Forest Service Region 5 staff. Published in multilith form by Region 5, 1954.

"Rainfall Sampling on Rugged Terrain," by E. L. Hamilton, U.S. Dept. Agr. Tech. Bul. No. 1096. December 1954.

"Hydrologic Analysis Used to Determine Effects of Fire on Peak Discharge and Erosion Rates in Southern California Watersheds," multilithed by Calif. Forest and Range Expt. Sta., February 1954. 49 pp. illus. By P. B. Rowe, C. M. Countryman, and H. C. Storey. The methods of hydrologic analysis described were used in one phase of a study to appraise the damages resulting from watershed fires in southern California. This report was not given general distribution but copies can be obtained upon request.

"Detecting Hydrologic Effects of Changes in Watershed Conditions by Double-Mass Analysis," by H. W. Anderson, Trans. Amer. Geophys. Union Vol. 36, No. 1, pp 119-125, February 1955. The double-mass plotting of hydrologic events against a meteorological control illustrates one way of detecting the effects of wildfires. Sedimentation and peak inflow of Gibraltar reservoir were found to have increased markedly following the wildfires of 1932 and 1933, then to have decreased as the watershed recovered from the fires. No change in the total annual inflow was detected using the same method. It was concluded that the effects of changes in watershed conditions must be taken into account in estimating long-term sedimentation and flood frequency from the short-term records now available.

"Streamflow Reactions of a Fire-Damaged Watershed," by J. D. Sinclair and E. L. Hamilton, Proceed. A.S.C.E., Vol. 81, Sep. No. 629, February 1955. The material covered by this paper was presented in the April-September 1954 Semiannual Report.

"Temperature Requirements for Germination in Relation to Wild land Seeding," by W. C. Ashby and H. Hellmers, Jour. Range Mgmt., March 1955. Germination rates as affected by temperature were determined for twenty species of grasses and forbs considered promising for wild land seeding in southern California. Laboratory findings were correlated with local field temperature and moisture conditions.

Manuscripts Accepted for Publication

"The Water Cycle," by W. C. Ackermann (ARS), H. O. Ogrosky (SCS), and E. A. Colman. For publication in USDA Yearbook, 1955. Describes the hydrologic cycle with emphasis on points in the cycle where man can exert influences on water.

"Soil Surveys on Forest and Range Lands," by J. A. Retzer (RM Station) and E. A. Colman. For publication in USDA Yearbook, 1955. Describes soil survey procedures for wild lands and shows how these differ from surveys made on cultivated lands.

"Root Systems of Some Chaparral Plants in Southern California," by H. Hellmers, J. S. Horton, G. Juhren, and J. O'Keefe, has been accepted by Ecology. The root systems of 68 plants, representing 18 species of shrubs and subshrubs, were studied. The relative importance of the different types of root systems observed is discussed in relation to the erosion and water yield problems of watershed management.

"Soil Fertility: A Watershed Management Problem in the San Gabriel Mountains of Southern California," by H. Hellmers, J. Bonner, and J. M. Kelleher, has been accepted by Soil Science. Reports the effects of fertilizing local mountain soils under greenhouse and field conditions.

"Development of Vegetation after Fire in the Chamise Chaparral of Southern California," by J. S. Horton and C. J. Kraebel, has been accepted by Ecology. Describes periodic observations of plant succession after fire on permanently marked plots through the period of rise and decline of the temporary vegetation, until the permanent shrubs again dominated the burned area.

New Manuscripts

"Operation Wet Blanket: Proposed Research in Snowpack Management in California," by E. A. Colman. Planned for A.G.U. Transactions.

"Reconnaissance Methods of Measuring Erosion," by C. H. Gleason. Presented at the December 1954 meeting of the AAAS in Berkeley, and being revised for submission to one of the technical journals.

"Forest Cover Effects on Snowpack Accumulation and Melt, Central Sierra Snow Laboratory," by H. W. Anderson. Planned for A.G.U. Transactions.

"Watershed Damage - Its Signs and Causes," by C. H. Gleason, Paul E. Packer (Int. Station), and Roy D. Hockensmith (SCS) originally planned for publication in the USDA Yearbook, is now proposed for submission to one of the semitechnical journals.

"Conquering Kennett's Gullies," by C. J. Kraebel. Planned for submission to American Forests. A picture story and description of planting and other work done to control erosion in the smelter-fume area of the upper Sacramento Valley.

"Western Mountain Floods," by J. D. Sinclair and G. W. Craddock (Int. Station) originally planned for publication in the USDA Yearbook, is now proposed for submission to one of the semitechnical journals.

CURRENT RESEARCH

SAN DIMAS EXPERIMENTAL FOREST

General

The research program on the San Dimas Experimental Forest was reviewed during a staff conference last October. One of the objectives of this review was to consider curtailing the collection and processing of rainfall and streamflow records from several watersheds within the San Dimas Forest; thus to concentrate effort on work of higher priority. As one result of this review an analysis of the forest's rainfall data was made, which led to the establishment of a "minimum" raingage network as described in the Rainfall section of this report.

A decision also was made to suspend streamflow records, except those of storm peak discharges, on four of the intermediate watersheds (Nos. IV, V, VI, and VII) within the Experimental Forest. Records of peak flows from these watersheds are being continued by means of an indicating device installed at the streamgaging stations.

The decision to curtail streamflow records was based upon several factors. First, the intermediate watersheds were set up primarily to determine the effects of channel treatments and chance wildfires on streamflow behavior, and in some instances to study the cumulative flow from several gaged watersheds. The watersheds on which streamflow records were suspended are not as suitable for channel treatment as are other forest watersheds on which records are being continued. The effects of wildfires during 1938 and 1953 in the Experimental Forest have been and are continuing to be studied. These studies lessen the need to continue the suspended streamflow records for similar comparisons of streamflow behavior before and after fire.

Second, manipulation of the vegetation or other treatment that might be planned in the watersheds from which records were discontinued will probably not be feasible for some time. Three of the watersheds are too large for treatment as units and in the fourth the presence of summer homes complicates the possibility of treatment.

Third, the records of streamflow already obtained from these low priority watersheds, plus the records of storm peak flows that are being continued, should meet our research needs.

Rainfall

Adequate sampling of rainfall on the SDEF has always been expensive and time consuming. When, in 1950, the network of about 300 vertical rain gages was supplanted by the network of 130 tilted gages, the work of record collection was lessened and sampling efficiency was improved. At that time we foresaw that further economies might be required, and a greatly simplified rainfall sampling system was planned. This "minimum" rain gage network was devised by selecting in each watershed a gage or a combination of gages whose annual catch came within 5 percent of the average catch of all existing gages in that watershed. The gages were also to be distributed so as to sample the watershed rainfall both as to area and elevation. Twenty gages were selected on this basis; ten were existing recording gages and the balance were standard gages in the newly established tilted gage network.

At the October staff conference it was decided that adoption of the minimum network would release funds and manpower now needed for other research projects. The minimum network was to be adopted if a statistical analysis showed that the gages in this network would give satisfactory measures of storm, as well as annual, rainfall for each altitudinal zone within each intermediate watershed.

An analysis procedure was set up wherein a random sample of 15 storms was drawn from the 77 storms or combinations of storms recorded during the 7 year period when records of minimum and original gages were available. Five storms were drawn for analysis from each of the following classes of storm rainfall: ≤ 1 inch, 1-3 inches, and > 3 inches. In each watershed with streamgaging controls the storm catch

of the minimum gage representing each altitudinal class was compared with the mean catch of all the gages at that altitude. A linear regression relation was established between these two values for the 15 storms selected, and the standard error of the relation calculated. A minimum gage was deemed acceptable if the standard error of estimate was not greater than 0.25 inch. The minimum gages selected earlier were evidently well chosen for the standard error in the relation of each gage was less than 0.25 inch. For individual gages the standard error ranged from 0.06 to 0.214 inches.

In the course of the analysis we found that 5 standard gages rather difficult of access could be replaced by more accessible recording gages or by averages of other gages. This rearrangement of the network reduced the number of gages from 20 to 17, and all but one of the standard gages were replaced by recording gages. This minimum network of 17 gages was put in operation before the first rains came in November 1954. The 77 gage network was left in place with the cans inverted. If necessary, the gages for any or all the watersheds can be put back in operation on short notice.

Procedures and results of the analysis were set forth in a progress report titled, "Simplified Method of Sampling Rainfall on the SDEF," by E. L. Hamilton.

Streamflow Calibration

Calibration analyses of weekly mean streamflow from watersheds VIII, IX, and X in the Big Dalton drainage described in the March and September 1954 semiannual reports, were continued. Regression analyses comparing the weekly means of streamflow in paired watersheds (streamflow from a watershed selected for future experimental treatment compared to streamflow from a control watershed) showed poor correlation in the flows, particularly during the wetting and drying periods of each hydrologic year. The poor correlation appeared to be due in large part to different responses of the watersheds to such variables as precipitation of the current week, precipitation of the last two days of the preceding week, soil moisture at the beginning of the week, and annual streamflow of the control watershed during the preceding year.

Multiple regression analyses employing the above variables are being made in an effort to improve the watershed calibrations. Procedures followed in these analyses are similar to those outlined by Anderson and Trobitz in their paper, "Influence of Some Watershed Variables on a Major Flood", Journal of Forestry, Vol. 47(5), pp. 347-356, 1949.

The analysis to determine variations in the disposition of rainfall in watershed IX during the years 1939 to 1953 has been completed. The calculating procedure followed was similar to that outlined by Rowe and Colman in USDA Tech. Bull. 1048, "Disposition of Rainfall in Two Mountain Areas in California".

Results of this analysis showed that total water yield (streamflow plus other drainage through the root zone) varied widely with the amount and distribution of annual rainfall (Table 1). The estimated total annual yield ranged from less than 0.05 inch to 29.4 inches and averaged 11.3 inches. On a long-time basis, less than 1/3 of this average yield is measured as streamflow. The proportion of water yield occurring as streamflow was generally greater during years of high than during years of low rainfall.

Year to year variations in evaporative loss were much smaller than the variations in annual water yield. Annual evaporative loss ranged from 11.5 to 18.8 inches and averaged 15.3 inches. Annual evaporative loss was influenced by the size and distribution of storms in a year and, during years of low rainfall, by the amount of water available for loss. In 8 of the 15 years of record, rainfall was inadequate to wet all the watershed soil to field capacity.

In 3 of the 15 years studied the maximum water storage consisting of subsurface storage plus subsurface yield was in excess of 22 inches during the year. However, examination of the storm rainfall-discharge relations indicates that the saturation capacity of the watershed was not reached or closely approached even during these years.

Lysimeters

The effects of the different cover types in the large lysimeters on annual surface runoff and soil moisture storage at the end of the growing season were studied this period. This is a part of a study of the disposition of precipitation by the various species, and a calibration to determine what magnitudes of treatment effects could be detected in the lysimeters.

Surface Runoff from the Lysimeters

Yearly surface runoff from the San Dimas large lysimeters for the years since they were planted with the present vegetation is shown in table 2.

Table 1.--Rainfall disposition by hydrologic years, 1938-39 through 1952-53, Volfe Canyon, Watershed IX, San Dimas Experimental Forest

Year	(P) Precipitation (1)	(Q) Streamflow (2)	(E) Evaporative loss[1] (3)	(S) Storage at end of year[2] (4)	(Q_t) Water yield[3] (5)
	Inches depth				
1938-39	21.6	0.9	13.4	7.3	8.2
1939-40	27.3	0.7	18.3	8.3	9.0
1940-41	48.2	12.5	18.8	16.9	29.4
1941-42	16.7	0.4	15.2	1.1	1.5
1942-43	45.2	13.1	17.0	15.1	28.2
1943-44	33.5	4.6	15.6	13.3	17.9
1944-45	29.6	3.0	15.4	11.2	14.2
1945-46	26.5	2.2	14.6	9.7	11.9
1946-47	28.1	1.9	17.2	9.0	10.9
1947-48	15.8	0.1	14.0	1.7	1.8
1948-49	17.1	0.2	13.9	3.0	3.2
1949-50	20.6	0.3	14.3	6.0	6.3
1950-51	11.5	[4] T	11.5	0	T
1951-52	41.1	7.5	17.9	15.7	23.2
1952-53	15.5	0.3	13.1	2.1	2.4
Average	26.6	3.2	15.3	8.1	11.3
Percent of P.		12.0	57.5	30.5	42.5

1/ Evaporative loss includes interception loss, evapo-transpiration, and riparian use.

2/ Storage = precipitation - (Streamflow + evaporative loss) all cumulated from beginning of hydrologic year. The storage at the end of each hydrologic year is assumed to be a measure of subsurface yield, but the exact time and place of delivery of this yield is unknown.

3/ Water yield = streamflow + storage at end of year.

4/ Less than .05.

Table 2.--Surface runoff from San Dimas large lysimeters

Year	Pre-cipitation	Surface runoff by species[1]						
		Bare	Buckwheat	Chamise	Ceanothus	Scrub-oak	Pine	Grass
		- - - - - - - - - - Inches - - - - - - - - - -						
1946-47	27.2	19.9	8.6	11.3	13.3	16.2	9.9	--
1947-48	15.6	9.5	4.8	7.0	7.1	6.6	7.0	--
1948-49	16.7	8.9	0.7	1.8	2.5	1.1	2.5	--
1949-50	20.6	13.4	4.4	6.4	6.5	4.9	7.3	--
1950-51	11.6	5.0	0.7	1.3	1.2	0.7	2.1	0.8
1951-52	42.2	29.2	16.3	17.7	17.4	18.0	18.8	17.2
1952-53	16.0	8.5	1.1	2.9	1.6	0.9	3.5	1.4
1953-54	25.4	18.5	7.2	8.6	6.6	5.7	9.8	8.7
Mean	21.9	14.11	5.48	7.12	7.02	6.76	7.61	[2] 7.02

1/ One bare lysimeter, average of 2 lysimeters with grass cover, and 3 to 5 lysimeters with other species.
2/ Average of 4 years.

Regression analysis of the annual runoff by individual species was made to test the responses of lysimeters with various species to rainfall for each year and age of cover. Because runoff from the bare lysimeter integrated storm sizes and rainfall amounts for a year, it was used as the meteorological control; the age since planting was used as the time control. The hypothesis was that runoff for each species would be proportional to runoff for the bare each year, that the proportional relation would change as the plants grew older, that this change in relation would accelerate with age, and that this change might be different for heavy rainfall years than for light rainfall years. It was also expected that any or all of these relations would vary between species. Of course, all parts of this hypothesis probably cannot be tested adequately with only 8 yearly records. However, the analysis was made as a reconnaissance step.

The hypothesis was tested by solution of an equation in which the elements listed above were included as variables such that: Surface Runoff (R) for a species (named) is a function of Bare Tank Runoff (BR), Plant Age (A) (1947 = age 1), Age squared (A^2), and Bare Tank Runoff times Age (BR·A). The results of analysis of the data in table 2 are given in the equations below:

$$R \text{ (Buckwheat)} = -1.69 + 0.504\ BR - 0.151\ A - 0.0495A^2 + 0.0303\ BR \cdot A$$

$$R \text{ (Chamise)} = 0.69 + 0.558\ BR - 0.704\ A + 0.0085\ A^2 + 0.0230\ BR \cdot A$$

$$R \text{ (Ceanothus)} = 0.64 + 0.728\ BR - 0.283\ A - 0.0465\ A^2 - 0.0022\ BR \cdot A$$

$$R \text{ (Scrub oak)} = -3.84 + 1.074\ BR - 0.329\ A + 0.0142\ A^2 - 0.0522\ BR \cdot A$$

$$R \text{ (Pine)} = 0.94 + 0.431\ BR - 0.248\ A - 0.0549\ A^2 + 0.0472\ BR \cdot A$$

The extreme variability in these functions between species is apparent. The analysis indicates that changes in runoff with age of the cover is significantly variable among species. Comparison of the regression coefficients for age, (A) and A^2) above, indicate that only for the chamise and the oak is the decline in runoff approaching an equilibrium with age. For the other species, runoff is decreasing at an increasing rate with age. The regression coefficients for the joint variable (BR·A) indicate that as the oak cover becomes older it is more effective in reducing surface runoff in the years with heavy runoff (in the bare). For the buckwheat, chamise, and pine the reverse is indicated; for the ceanothus the effect is essentially zero. It is too early to tell through what processes these species bring about these differences and to what extent the differences are peculiar to the lysimeter instrument. However, it seems probable that these are real physical differences because each lysimeter of a given species gives almost exactly the same response.

Soil Moisture Storage in Lysimeters

As another element in rainfall disposition, the quantity of water remaining in the lysimeter soil at the end of the dry season was compared between species. Basic data given in table 3 was examined by analysis of variance.

Results of the analysis indicated that there was no significant difference in fall soil water content between the means of lysimeters supporting buckwheat, chamise, and ceanothus. The oak and pine tanks differed significantly from the others, but not from each other, retaining about 0.9 inch (16 percent) more water than did the average of the other tanks.

In the comparison between years soil moisture storage in only the first year (1946-47) and the heavy rainfall year 1951-52 differed significantly from the other years and from each other. Soil moisture storage was 1.3 inches more than average in 1946-47 and 0.7 inch more than average in 1951-52. The method of comparison used was that given by Snedecor (Statistical Methods, 4th ed. p. 266).

The grass tanks obviously retained considerably more water in the fall than did any of the other tanks, as is shown in table 3. Even without statistical analysis it is evident that the difference between fall water storage under grass and under each of the other species is significant. It was found that the grass lysimeters held an average of 10.5 inches more water than the brush lysimeters and 9.6 inches more than the oak and pine (using the method of comparison in Snedecor op. cit. p. 257). This excess moisture in the grass came largely from the single rainfall year 1951-52. Perhaps this excess moisture in the grass lysimeters will be held until another heavy rainfall year so that it will contribute to increased water yield. Perhaps, though, all or part of the moisture will be lost by transpiration of invading deep-rooted species before another heavy rainfall year occurs. If a heavy rainfall year occurs while extra soil moisture still exists in the grass lysimeters the increased yield may occur partly as increased surface runoff. To test this second effect, it seems worth while to prevent invasion of deep-rooted herbaceous species for a time.

Table 3.--Soil moisture in San Dimas lysimeters at close of hydrologic year

Year	Average soil moisture in lysimeters by type of cover							
	Bare	Grass 1/	Buckwheat	Chamise	Ceanothus	Oak	Pine	Mean brush & pine
	Inches depth							
1946-47	15.0		6.5	6.7	6.6	9.9	7.7	7.48
1947-48	14.2		5.6	6.6	6.0	6.1	7.3	6.32
1948-49	15.8		5.7	6.1	5.8	6.3	6.8	6.14
1949-50	15.2		5.6	6.0	5.8	6.5	6.6	6.10
1950-51	14.2		5.8	5.7	6.5	6.1	6.4	6.10
1951-52	15.4	16.5	6.1	5.9	6.6	8.2	7.5	6.86
1952-53	15.6	17.4	5.8	5.8	5.8	6.2	6.6	6.04
1953-54	15.0	15.6	5.7	6.0	5.8	6.4	6.7	6.12
Mean	15.0	16.5	5.85	6.10	6.11	6.96	6.95	6.40

1/ Annual and perennial.

MEETINGS

October 6.--Kraebel talked to the Forestry Club of the University of California on "Careers in Forestry".

October 11.--Hamilton gave an illustrated talk to 50 members of the Azusa Rotary Club on "Streamflow Reactions of a Fire-Damaged Watershed".

October 15.--Hellmers spoke at a meeting of the Altadena Kiwanis Club on "Vegetation and Flood Control".

October 27.--Sinclair attended the Southern California Zone Forest Supervisors' Committee meeting at Arcadia called to consider material to be presented to the Watershed Fire Council of Southern California and at the public hearing being sponsored by the State Board of Forestry.

November 4.--Hamilton spoke before a class of pre-engineering students at Citrus Junior College on "Engineering Aspects of the San Dimas Experimental Forest". Sixteen were present.

November 18.--Anderson talked to a Civil Engineering Seminar at the California Institute of Technology on "Measuring the Hydrologic Potential of Watersheds and the Effects of Watershed Conditions". About 40 were in attendance.

December 8-9.--Colman attended the Vicksburg, Mississippi meeting of consultants for the Vicksburg Infiltration Project.

December 8.--Director Jemison read Colman's paper "Water Control and Timber Management" at the annual meeting of the Western Forestry and Conservation Association in San Francisco.

December 30.--Gleason presented a paper at the General Geology Session, American Association for the Advancement of Science, meeting at Berkeley, on "Reconnaissance Methods of Measuring Erosion".

January 7.--Rowe discussed the work of the San Dimas Experimental Forest and its application to watershed management problems in southern California at an annual Soil Conservation Service District Training Conference held at San Fernando, California. About 35 members of the District's staff were present.

January 20.--Hellmers spoke to the ecology class of Pomona College on "The Effect of Fire on Southern California Vegetation".

January 22.--Kraebel talked to the social studies section of the College Women's Club of Berkeley on "Conservation Problems and Practices on the National Forests of California".

January 26.--Gleason spoke to the Conservation class of Prof. Wayne Kartchner at San Jose State College on the subject of "Watershed Management". About 90 students attended.

February 1-5.--Sinclair with several other Forest Service representatives attended the convention of the National Association of Soil Conservation Districts held at San Diego. The Research Committee of the National Association recommended increases in appropriations to the Department of Agriculture for research in watershed hydrology, soil, and water management grassland problems and economics of soil and water conservation. These recommendations also received convention approval. The convention was attended by about 2,000 members of soil conservation districts throughout the country.

February 4.--Anderson and Colman presented papers on snowpack management at the Berkeley meeting of the Pacific Southwest Section American Geophysical Union.

February 7.--Anderson outlined and illustrated hydrologic analysis methods used for flood prevention evaluation at a meeting in Sacramento. The meeting was arranged by Colman at the suggestion of Assistant State Engineer T. Waddell. Carl Meyer and Robin Reynolds represented the state. Colman and Lawrence (R-5) contributed to the discussions.

February 17.--Sinclair was invited to the annual meeting of the San Dimas Water Company and spoke briefly about current research and the effects of the 1953 fire on the San Dimas Experimental Forest.

February 28.--Colman discussed snow research at the Fresno meeting of the San Joaquin Valley Council, State Chamber of Commerce.

March 3.--Rowe spoke on "Watershed Management Research Carried on at the San Dimas Research Center" before the Hydraulics Division of the Southern California Section of the American Society of Civil Engineers. Some 45 members were in attendance.

March 4.--Jemison discussed snow research at the Sacramento meeting of the Sacramento Valley Council, State Chamber of Commerce.

March 11.--Jemison discussed snow research at the Stockton meeting of the Central Valley Council, State Chamber of Commerce.

March 16.--Colman discussed snow research in Corning before the Corning and Orland Rotary Clubs.

March 16-17.--Anderson attended the California Cooperative Snow Conference held at Fresno and spoke on the subject "Forest Effects on Snowpack Accumulation and Melt, Central Sierra Snow Laboratory".

March 29.--Hellmers, with Ranger Carl Wilson, of the Angeles National Forest attended the Franklin High School, Highland Park, Vocational Day Program. They spoke to a group of approximately 40 students who attended the forestry conference.

COOPERATION

Angeles National Forest.--Hellmers, at the request of Supervisor Mendenhall, inspected the Sable burn in the Saugus District. He recommended that the Angeles Forest portion of this burn should not be sown because the erosion hazard was low.

San Bernardino National Forest.--Hellmers, at the request of Supervisor Jarvi, joined G. Juhren of the Angeles National Forest, C. Davidson of the Regional Office, and J. Dean and J. Merriam of the Soil Conservation Service on an inspection of the Panorama burn of September, 1954. This burn extended from the mouth of Devil Canyon, north of the city of San Bernardino, to the top of the mountains near the town of Crestline. The group agreed that the burn should be sown to a mixture of ryegrass and mustard.

Northeastern Forest and Range Experiment Station and Morris Arboretum.--Hellmers, at the request of the Northeastern Station, collected acorns and herbarium specimens of six species of oak native to southern California. The acorns are to be used in establishing specimen trees in the Michaux Quercetum.

Bureau of Reclamation, Sacramento.--Mr. C. H. Spencer of the Bureau's Hydrology Section was furnished the results of the Forest Service's sediment sampling in the Santa Maria River watershed during 1941.

Barrud Productions, Hollywood.--Sinclair, with F. L. Hanes and A. L. Jensen of the Conservation Committee of American Legion Post 13 at Pasadena, conferred with representatives of Barrud Productions concerning the possibilities of a television broadcast of watershed research on the San Dimas Experimental Forest. Messrs. Barrud and Spalls, of Barrud Productions, were interested in this proposal made by the Conservation Committee, and they plan to visit the San Dimas area to explore the possibilities on the ground.

Danial, Mann, Johnson, and Mendenhall--Architects--Engineers, Los Angeles.--John W. Ferguson called at the Glendora office to obtain data and discuss methods of estimating probable flood discharge and erosion rates from burned-over watersheds that threaten the city of San Bernardino. This information was to be used in planning and designing flood control structures.

Southern Forest and Range Experiment Station, Vicksburg Infiltration Project.--Horton visited Glendora and arranged to obtain a considerable volume of soil moisture data and related results from the Tanbark lysimeters and plots.

Los Angeles County Flood Control District.--Rowe accompanied M. R. Howlett of the Angeles Forest and E. C. Kenyon, W. R. Ferrell, and H. H. Haile of Los Angeles County Flood Control District on an inspection of the slope and channel stabilization work of the Forest Service flood control project in Los Angeles River watershed.

State of California.--Kraebel reviewed the draft of a report: "Forest Regeneration in California", prepared by F. S. Baker, Chairman of a regeneration committee of which Kraebel is a member. The report was compiled at the request of the State Board of Forestry, of which Dean Baker is an ex-officio member.

Corps of Engineers, U. S. Army.--Kraebel and Gleason accompanied the Chief Planner of the San Francisco District to advise on measures of erosion prevention on military installations in the East Bay hills.

Southern Pacific Railroad Company.--Kraebel met with the company's Land Commissioner and staff of foresters to discuss problems of erosion reduction and watershed protection on their timber sale areas.

VISITORS

The San Dimas Experimental Forest was visited by approximately 250 people during the last six months. About half of this number, including groups of teachers and members of the Izaac Walton League and Audubon Society, were guided by the Mt. Baldy District Ranger and his staff.

Visitors conducted by the Experimental Forest Staff included: Five faculty members and 67 students in hydrology, irrigation, soils, and geology classes from the California Institute of Technology, California Polytechnic Institute, and Citrus Junior College; a group of 10 residents of Santa Barbara County interested in brush conversion; representatives from the U. S. Geological Survey and Corps of Engineers; and specialists from Argentina, Australia, Egypt, India, Japan, New Zealand, and Norway.

Mr. Emil Hohlwegler, Minister of Labor from West Germany was a visitor at Berkeley headquarters.

Mr. R. G. Downes, Deputy Chairman of the Soil Conservation Authority, Melbourne, Victoria, Australia, visited both the Berkeley office and the SDEF, for conferences on problems of watershed management.

SEMIANNUAL REPORT ON FOREST WATERSHED MANAGEMENT

Central States Forest Experiment Station

Athens Research Center

October 1954 -- March 1955

General

This past winter has been partially devoted to studies of soil moisture and water runoff at the Vinton Furnace Experimental Forest. Analysis of soil samples taken in connection with current studies of the site quality of even-aged oak stands has been initiated.

Rainfall has been above average during the winter of 1954-55. Rains in February and March resulted in the inundation on the bottomlands along many small streams in Ohio. Excessive runoff resulted in floods along the Ohio River that caused considerable damage to many communities bordering the river. Measurements at the Experimental Forest showed that the soils reached field capacity in early January.

Meetings

In January the staff attended the annual meeting of the Ohio Forestry Association. A scale model of an experimental forest watershed constructed by the research center was exhibited at this meeting. This model will become a permanent exhibit in the Agriculture Building at Ohio University.

Merz and Carmean attended the Golden Anniversary meeting of R-9 Forest Supervisors held at Madison, Wisconsin in February. Merz participated in a panel on cooperative research and Carmean presided in a panel on forest watershed management.

In February all personnel of the Athens Center attended a program conference of the entire staff of the Central States Forest Experiment Station in Columbus, Ohio.

Merz presented a paper entitled "Some Forest and Water Relationships" before a meeting of the Forestry Section of the Association of Southern Agricultural Workers in February.

In April, Boyce and Carmean will present an informal paper at the annual meeting of the Ohio Academy of Science on the preliminary results of studies of plant indicators related to black oak site quality.

Current Studies

Details concerning current soil-site studies of upland hardwoods have been previously described. Water runoff and soil moisture studies in connection with a silvicultural study of the conversion of poor-site hardwood ridges to pine have also been described in previous semi-annual reports.

Soil-site studies will continue through 1956. It is planned to prepare papers on the soil-site and plant indicator-site aspects of these studies. A preliminary analysis of the black oak site plots indicates that the following species are correlated with poor site conditions for black oak: Antennaria fallax; Cunila spp.; Potentilla spp.; and Vaccinium vacillans. Indicators of good-site conditions for black oak appear to be: Aster cordifolius; Carex spp.; Galium spp.; and Smilicina racemosa.

Studies to determine differences in soil moisture between clear-cut and undisturbed oak stands will be terminated this spring. A report on this study should be completed by the fall of 1955.

Surface water runoff measurements from undisturbed and clearcut plots are continuing. Two additional runoff troughs have been placed in a nearby old field that has been abandoned for approximately 15 years. Initial results show that surface runoff from the clearcut plots is four to five times as great as from undisturbed oak stands. During heavy rains surface water runoff from the abandoned field, however, is 20 to 30 times greater than the runoff from the undisturbed oak stands.

Water samples for sediment analysis are currently being collected from two undisturbed forested watersheds. One of these watersheds will eventually be clearcut and the other will be cut by the group selection method. Water sampling for sediment will be continued through the cutting period so that the amount of erosion and sedimentation resulting from cutting and logging can be determined.

SEMIANNUAL REPORT OF WATERSHED MANAGEMENT RESEARCH
Intermountain Forest and Range Experiment Station
September 1954-March 1955

Boise Research Center

Logging Disturbance-Sediment Production Study - The installation and initial area-capacity measurements of 20 dams and sediment debris basins for studying the effects of ponderosa pine logging disturbance on sediment production in the Boise Basin Experimental Forest was completed late in the fall. Initial surveys of sediment source areas were also completed. Cutting and logging on a replicate set of 8 compartments was completed in the fall, as was nearly all of the postlogging erosion control treatment of skidtrails and haul roads. The stage is thus set for getting the first complete set of sediment production records following snowmelt in 1955.

Other portions of the experimental forest which are not being used for the current FM-R1 study were investigated for possible use in a study of the hydrology of ponderosa pine. Three sub watersheds in virgin condition were found to offer promise for such a study.

Erosion Control Study - Postlogging treatments were applied on 5 timber sale areas within the Boise and Payette National Forest during the past fall to complete the initial phase of study of erosion control measures on skidtrails and haul roads. First measurements and observations on the test areas will be made in 1955.

Missoula Research Center

Paul E. Packer was transferred from the Boise Research Center to Missoula during the winter to initiate a program of watershed research in the Northern Rocky Mountain portion of the Station territory. He will look into the watershed problems in both the Missouri River and Columbia River drainage basins as a basis for making program recommendations. Thus far he has found most concern centering on a soil stability and runoff control problem in the deep snow-spruce forest lands where insect control has necessitated a greatly accelerated program of clear-cutting and logging operations.

Wasatch Research Center

A detailed analysis is being made of the climatic and streamflow records from the Davis County Experimental Watershed with a view toward preparing a comprehensive report on the hydrologic behavior of that area. One of the important aspects is the high degree of control achieved over summer rain floods. The other is the effect of the control measures on water yields by seepage flow processes.

The analyses thus far indicate the watershed improvement measures (protection from fire and grazing, reseeding, and contour trenching) have significantly reduced early spring snowmelt runoff but have not altered water yields in the summer and fall seasons.

Who Has the Rainiest Rain Forest? - C. W. Thornthwaite reported some remarkably high infiltration rates on a wooded portion of the water-spreading area at the Seabrook Farms in New Jersey. In one of his reports he suggested the wooded spreading area was the "rainiest rain forest in the world." This prompted an analysis of the infiltration rates on two waterspreading projects near the Davis County Experimental Watersheds in northern Utah.

One of these is the Centerville project which has been in operation for 17 years. This project consists of a level trench about 1 acre in size cut into one of the terraces formed by ancient Lake Bonneville immediately south of the mouth of Centerville Creek Watershed. Each year surplus water from Centerville Creek has been diverted into the trench for spreading to increase underground storage.

During one period of 222 days (October 21, 1938 to May 31, 1949) 415 acre feet of water were diverted into the spreading basin. The average wetted area of the basin was approximately .83 acre. The total infiltration and evaporation was about 6,000 inches, and the rate was about 27 inches per day per unit of area exposed.

On two other occasions when inflow to the spreading basin was shut off, records were obtained of the water levels. During one 30-hour period the water level decreased 4.6 feet. This is equivalent to an infiltration rate of 38.7 inches in 24 hours per unit of area exposed. During another 6-hour test period the change in water level indicated an infiltration of 28 inches per 24 hours per unit of exposed area.

A second waterspreading project was developed in 1941 east of Bountiful, Utah, about 2 miles south of the Centerville project. Here, local water users attempted to spread and infiltrate water in a small basin that had been made by a bulldozer. This attempt failed. A. R. Croft, who was then in charge of the Davis County Experimental Watershed, suggested turning the diverted streamflow into a nearby patch of oak-brush and chokecherry about 5 acres in size. This was done. All of the water was absorbed within the brush patch. Moreover, examinations revealed that the spreading and infiltration was accomplished on only 2.5 acres of the 5.0 acre spreading area. Use of the brush area for spreading water was continued for several years.

During an 111-day period in the spring of 1946, this area absorbed 450 acre feet of water. This is equivalent to 2,160 inches of water and a rate of 19.46 inches per day per unit area exposed. In other years there were 4 different periods of about 120 days each when from 1,440 to 2,160 inches of water were spread and absorbed.

The infiltration rates at both the Bountiful and Centerville projects greatly exceed the maximum rates reported by Thornthwaite. Could it be that arid Utah rather than the Seabrook Farm has "the rainiest rain forest in the world?"

Soil Moisture-Strength Survey - Observations and records of soil moisture and other soil characteristics were continued during the fall and winter season at about 145 study sites in Utah, Nevada, and southern Utah. Field records are to be continued through the spring season of 1955 after which they will be analyzed to determine the accuracy of prediction methods developed by the Infiltration Project at Vicksburg, Mississippi. The survey study is scheduled for completion by June 30, 1955.

Great Basin Research Center

The runoff records from two subalpine watersheds of about 300 acres each in size were subjected to critical scrutiny during the winter. This analysis showed the areas to be potentially useful for evaluating the effects of intensive watershed improvement measures on seepage flow water yields, as well as summer storm runoff. Some deficiencies in the records need to be rectified, however, in order to improve their sensitiveness. One of the problems is to overcome icing in the flumes during the early period of the snowmelt period. Another is better sampling of the snow cover. Plans are being formulated to cope with these problems.

The Station has assumed responsibility for planning and technical direction of a study to evaluate the hydrologic and forage production effects of the upstream portion of a $327,000 improvement program in the Pleasant Creek Watershed near Mt. Pleasant, Utah. One phase of the study will be a comparison of records from range plots and infiltrometer tests made this year prior to treatment, and repeat measurements 3 years after treatment. Another phase will furnish records on the effects of contour trenching on runoff and sediment production. Detailed study plans for this effort are now being developed.

Plans are also being developed for a study this summer of the effects of reseeding on the infiltration, runoff, and erosion characteristics of a large summer-range area in Manti Canyon on the Manti-La Sal National Forest. Plots for this study were established 3 years ago when the reseeding work was done through a cooperative arrangement with National Forest Administration. Tests are to be made on treated and untreated paired sites this season prior to reopening the area to livestock grazing. It is planned to make followup tests a few years later to evaluate the effects of grazing.

Prior to the advent of snow last fall, soil moisture samples were obtained on a 10,000-foot elevation study area in the head of Ephraim Canyon as part of a study of the efficiency with which

summer range forage species utilize water. Volume weight and field capacity values are to be obtained from these sites this spring following the disappearance of snow as a basis for completing this exploratory story. The data thus far indicate some promising and useful information will be forthcoming. Because of these encouraging results, plans have been made for extending the study to include a large number of species that have proved to be well adapted for reseeding on depleted high elevation summer range in central Utah.

NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report April 1955

GENERAL

It will be no surprise to our readers that these unsigned reports do not magically appear on our desk April 1, full-bodied with accounts of the past 6 months, and ready for the outgoing basket. Never happens. They're the work--largely unexpurgated--of several who, for this one time at least, will receive due credit. Irv Reigner, unaided, writes the Kingston copy with a scrub-oak quill. Dick Trimble is responsible for the report from the White Pine-Hardwood Research Center. Everything's new up there: Dick uses a ball-point. Sid Weitzman, wearing his influences hat, composes the Mountain State offering. The miserable introduction is Lull's work.

New soil moisture measurer

Reigner and Lull visited Seabrook Farms recently and were treated to a glimpse of the latest in soil-moisture measuring instruments, and a tour of the well-known recharge area. The soil-moisture instrument is the commercial version of the portable slow neutron flux meter described by Underwood et al in Soil Science 77: 339, 1954. Now called a "neutron moisture scanner", this instrument is manufactured and sold by William B. Johnson and Associates, Empire State Building, New York 1, New York. Its cost, including the neutron source, is about $1400.00. The instrument, weighing 13 pounds, is a "self-contained battery powered unit, ruggedized for use, which may be calibrated to give direct moisture readings in percent by volume, for both surface and depth type measurements". According to the maker, it requires but one calibration for all soil types, and moisture content value can be obtained for about a 6-inch soil layer in 2 to 3 minutes. For details and photos of the instrument, write Mr. Johnson.

Seabrook recharge

Dr. Irwin Remson of the Geological Survey took us over the recharge area described in the recent mimeo release from the Washington Office. According to this release, one of the major questions to be settled was why infiltration was so much greater in the woodland than in the clover field where recharge was not possible. The answer, according to Remson, was that the clover field possessed a very evident plowsole which limited infiltration.

The most striking features of the two recharge zones we visited were the dead trees, debarked by streams of water from the high pressure nozzles; the change in ground cover from Vaccinaceous species to a dense cover of pokeweed and elderberry, and in one zone, grass; and the formation of a 2 to 3-inch mull containing organic fragments from the waste water.

This area will continue to be used for recharge. From our observations, much of the woodland is dead. The high infiltration rates can be ascribed to the protection the ground cover offers, the type of soil--a permeable sand, and most important, the undisturbed condition of the soil.

Dr. Remson has prepared several papers describing results of his studies in this area. Two of his papers will be published shortly in the Transactions, AGU.

KINGSTON RESEARCH CENTER

Howard Lull, our new Division Chief, has spent considerable time with us since the last report. Besides, familiarizing himself with the Dilldown and Pocono projects and getting involved in our numerous problems, Howard now has a speaking acquaintance with real scrub oak and a stumbling acquaintance with the rocky terrain at the Pocono Forest.

Precipitation, Stream flow and Water Loss

By a slight amount, water year 1953-54 was the driest yet measured at the Dilldown Watershed. Total precipitation was 45.03 inches, compared to 45.12 inches in 1949-50.

We anticipated a low annual runoff, but did not expect it to be so drastically low--only 20.81 inches. This was nearly 5 inches less than the previous low of 25.41 inches in water year 1948-49.

This is the first year in which water loss exceeded 50 percent at the Dilldown Watershed. The high water loss, percentage wise, was apparently the result of rainfall distribution. We hope, anyway, that it was not caused by increased water use by the vegetation during this calibration period.

Watershed Calibration

Measurements at the Dilldown Watershed are now in the seventh water year. Certainly it is high time to begin analysis to find out if the present data are sufficient to consider the watershed calibrated with its present scrub oak cover.

As far as we know, the standardization of a watershed on itself for water yield comparisons has never been fully tried. Heretofore, watershed treatment effects have been mostly determined by comparisons with a control watershed. At the Dilldown Watershed, for which there is no control, relationships with climatic factors set up during "control" period will be used for comparison with relationships determined after treatment.

Lull and Reigner are about to embark on the process of determining if these "control" relationships are now adequately defined. It is expected that aid and assistance may be needed from Kovner, at Coweeta, who has been developing useful techniques.

Snow, Lack Of

One of the several facets of the water regime that was expected to be affected by watershed treatment of the Delaware-Lehigh Experimental Forest was the depth of the snow pack and its duration or rate of melting. Obviously, a change in watershed cover from low brush to high forest should result

in a different amount of snow interception; also, the increased shading should hold the snow pack longer. And certainly, snow would be important and plentiful--the old-timers of the area said so!

We now wonder where all the snow has gone. Into the next county? Are we in a warm cycle, or has the slight warming of the climate reduced the snowfall? Or were the old-timers guilty of believing their own exaggerations? Anyway, in seven winters the snow pack has been shallow, intermittent, often incomplete and altogether unimportant.

Until this year, we assumed the winters were warmer than normal and that this abnormality was reflected in the snowfall. But this winter has not been warmer than normal--it's been a dinger. Nevertheless, the snowfall has been less than ever. Not once has the snow been deep enough or lasted long enough to warrant a snow course measurement. Perhaps we just haven't sampled enough winters.

Scrub Oak Conversion

The final draft of a plan to convert the vegetation on the Dilldown Watershed from scrub oak brush to high forest is nearing completion. It will then be presented to the Pennsylvania Department of Forests and Waters for their consideration.

The installation of permanent photo plots on the Dilldown Watershed began in October. Two plots are being located in each of the 16 categories of vegetative cover on the watershed. Photographs in black and white and Kodachrome are being taken at each plot. Plans are to rephoto these plots at 5-year intervals.

Another phase of the chemical release study was completed on November 1. A water emulsion was applied for comparison with the usual 2,4,5-T in oil. All went well until the hose blew off the pressure sprayer--good subject for slapstick comedy. Very disconcerting. Not all the solution was lost--we had enough to finish the job adequately.

Chemical Site Treatment

It is becoming obvious that seedlings planted in the untreated brush are growing with less vigor than those planted on treated areas. Comparing similar plantings made in furrows, in an area treated with Ammate, and in an adjacent untreated area, red, jack, and pitch pine seedlings show greater growth in the treated areas. As the ammate treatment did not kill the scrub oak (as it was supposed to) but did kill much of the herbaceous ground cover, it appears that the latter may be the limiting factor.

Considering the dense root mat it forms in the humus layer and upper A_2 horizon, it is easy to visualize that the low ground cover, blueberry, sheep laurel, etc., may compete seriously for moisture with the planted stock. Accordingly, a study has been devised to prepare planting spots by killing the ground cover with herbicides. Various herbicides and concentrations will be tried on spots 18 to 24 inches in diameter. The spots will be planted in spring. Any residual toxicity will soon be evident and the

effect of the site treatment on growth will be measured in several years. A work plan was prepared in December. Suitable weather for spraying did not occur until March 10 and 11.

Our chief concern now is how to find the spots. Had the spots been prepared in the fall, the dead vegetation would be visible without difficulty; and the spots will be visible in the spring of 1956. But there is some question about their visibility about 6 weeks after spraying.

Publications

Tables are being prepared and writing is underway for the third Dilldown Report. Previous reports were published by the Pennsylvania Department of Forests and Waters in 1951 and 1953. The compilations represent a sizeable job, but the publication should be ready for review by June.

This report will include very little new material other than the data tables. Reigner will discuss the hydrology phases of the project during the two-year period and will collaborate with McNamara and McQuilkin in discussing scrub oak conversion results to date. Lull will write the introduction.

Reigner has prepared a detailed handbook of field procedures for obtaining hydrologic data at the Dilldown Watershed and another for the watershed project at the Pocono Experimental Forest. After review by Dixon Miller, the resident hydrographer at Dilldown, revisions are now being made for the final draft. Other handbooks are to be prepared for office procedures and for maintenance of hydrologic instruments.

Infiltration Project

With the advent of Spring, the Northeast Extension of the Vicksburg Infiltration Project has removed its truck from winter storage and started the spring sampling schedule. This schedule consists of three sampling rounds of all the sites.

Ralph Moyle, Beryl Jones, and Art Eschner completed five sampling rounds before the middle of November. The time from the last fall sampling to the first sampling in the spring was consumed in the office working on collected data. It might be interesting to note the accomplishments of the five sampling rounds. They consist of approximately 25,000 man miles travelled, 22,500 soil strength measurements, 2,250 soil moisture values, and 1,080 bulk density measurements. In the office, saturation and 60 cm tension values were obtained from the bulk density cores; and trial predictions ran at each site for the period of sampling.

The Soil Conservation Service has been very cooperative in obtaining the correct names for the different soils. To date, the soils in Pennsylvania have been named, and a schedule developed for further identification in the other states.

Moyle and his group also helped bring to date Dilldown climatic and streamflow compilations.

MOUNTAIN STATE RESEARCH CENTER

During the late summer and early fall, this section of West Virginia had two heavy rainfalls as by-products of hurricane activity. They were unusual enough that bridges were washed out, communities cut off, and several towns isolated for a day or longer.

These rains were a good test of road layout and maintenance recommended as a result of studies on the Fernow. Inspections immediately after each rainfall showed that wherever roads had been put in according to our standards, erosion was at a minimum. Old type road construction did not hold up in critical spots. In many instances old type roads cannot even be reconstructed at the same location.

Weitzman, assisted by Dick Jones and Gil Varney, spent three days in New York teaching road layout, construction and maintenance, at a school called by Region 7. The school was essentially designed for foresters engaged in the small watershed program.

Lull visited us in February, bringing a heavy snowstorm. He and Fridley floundered around the gage network recording snow depths and water contents, and an early-morning temperature of -14° F.

Addenta

Weitzman attended the Allegheny Section, SAF meeting in Pittsburgh. The theme of the meeting was watershed management. Sid presented a paper, "Management of Forests for Water Conservation."

Burley Fridley is maintaining records at the Fernow while we wait for a replacement for Trimble. Apparently men of Trimble's calibre are hard to find.

Carl Barr addressed the Eastern Maine Forest Forum. He talked on skid road location and construction.

A representative of the Virginia Forest Service brought a logger and a landowner to the Fernow to negotiate terms and methods based on our research results.

Paul Shull of the Armstrong Paper Company visited the Fernow and inspected our logging road studies. He plans to have his staff down this summer or fall.

The Fernow staff is now using their new office building recently completed at the nursery.

WHITE PINE-HARDWOOD RESEARCH CENTER

Selecting the new experimental area for watershed management studies in New Hampshire began in the latter part of August, but the final choice was not made until late in September. The area chosen is the Hubbard Brook watershed, a tributary of the Pemigewasset River. It flows into the Pemigewasset from the west at West Thornton, which is a small community 13 miles north of Plymouth, New Hampshire. This research watershed, which is part of the White Mountain National Forest, covers about 7500 acres. The main stream flows in a west-east direction and has enough permanent flow tributaries draining both the north and south slopes to make it suitable for watershed studies. The watershed is completely forested--mostly with northern hardwoods, but with some spruce-hardwoods and scattered patches of spruce and fir. The original stand was logged about 40 years ago, and there has been little cutting since then. Soils on the watershed are shallow and bouldery.

Bob Pierce, the last man currently assigned to the new project arrived early in January. He came from the Vicksburg, Mississippi Infiltration Project. Sartz had reported on October 18, and Trimble on November 10.

Preliminary work started

We do not yet have accurate, large-scale maps for the Hubbard Brook watershed. To remedy this situation, a special air-photo project was flown on November 10 by Forest Service personnel and airplane from the Beltsville Forest Insect Laboratory. We now have several sets of good contact prints at a scale of 1:7920 and also photo mosaics of the whole area.

Trimble and Sartz spent some time last fall scouting the area for a good road location and looking for good weir sites. We hope to get our first weir construction underway this spring.

Logging Road Erosion Observations

The hurricanes of last fall helped focus attention on a problem which had not been considered too important here before: skidroad erosion. The heavy rains accompanying the hurricanes caused costly erosion damages on certain small areas. But further observations showed that severe erosion is not strictly a hurricane phenomenon in the White Mountains. Gullies four and five feet deep had developed on some skidroads before the hurricane rains of this year hit the area. These were caused by rapid runoff from melting snow. Where waterbars had been properly installed, however, soil loss was at a minimum. Obviously the granitic forest soils of the White Mountains are extremely erosive where the mineral soil has been exposed, and logging and skidroad erosion control is an important part of the forest management job in this area.

Winter activities

Frost data have been taken for a number of years as part of the Station's forest influences program. These data have never been thoroughly organized and analyzed. Pierce is working on this now.

An exploratory snow study was begun early this year at Hubbard Brook to give us an idea of the seasonal snowfall pattern on the watershed. Four plots for each of the two major aspects (north and south) were laid out at elevation intervals of 500 feet from 1000 feet above sea level to 2500 feet. Snow depth and the water content have been measured on each of these plots at two-week-or-so intervals throughout the winter. The maximum peak in the snow pack came sometime in March. Maximum snow depth at the higher elevations was more than three feet, with a water equivalent of 10 to 12 inches. Variation by elevation was less than expected.

A working plan has been prepared and field measurements have begun on another snow study--this one at the Bartlett Experimental Forest. The purpose of this study is to determine the effects of northern hardwood forests on both the accumulation and rate of melt of snow. The Bartlett area was selected because the system of patch cuttings on the forest lends itself very well to this type of study. The effect of two different hardwood forest conditions is being studied, well-stocked pole timber, and old-growth sawtimber. Measurements of snow depth and water content are being made in small clearcut openings in each of these stands and in the surrounding forest. This study will be carried on for two or three years so that variations in annual snowfall will have had a chance to express themselves. Analysis of the measurements made so far shows that there is a considerable and highly significant difference between snow depths in the openings and in the stands surrounding them. Differences in water contents tend to be of a lower magnitude.

Our snow studies this year are also giving us "the feel" of this kind of work. They are showing us what kind of point-to-point variations we can expect in snow packs; and they are disclosing some problems inherent in snow surveying. One of the more knotty problems is how to measure the effect of forests on snow accumulation without confounding this with their effect on the rate of melt. We have found indications this winter, for example, that there had been some loss of water from the snowpack by melting even before the maximum accumulation was reached. During the build-up of the snow pack the forest canopy reduces net snowfall through interception. However, during melt periods the effect of the forest cover is just the opposite; it retards melting. Thus, unless great care is exercised in studying canopy effects, the results can easily be confused. This is especially true during late winter when the processes of snow accumulation and melt frequently alternate. Failure to differentiate between these two processes may be one reason why past studies of the effect of hardwood canopies on snow accumulation have given such conflicting results.

Soil Survey Planned for Hubbard Brook

A cooperative agreement has been made with the Soil Conservation Service for assisting us in making a soil survey of our experimental watershed. A reconnaissance survey of the whole area will be made this summer. Detailed surveys of individual watersheds will begin next field season. Pierce will work with the SCS man on these surveys. SCS has a special interest in this project. For them it is a pilot plant study in which to work out systems of classifying and mapping forest soils for use in both timber management and watershed management work.

We have begun to accumulate some soils laboratory equipment. However, it will be some time before we have everything needed for a complete soils lab setup. In the meantime, the Agronomy Department of the University of New Hamsphire has offered us the use of their facilities.

Talks, Meetings, and other items

Howard Lull spent a week with us in the early part of February. He helped Pierce get started with the frost analysis, and went over with us our programs of work, and equipment needs. And we showed him what Hubbard Brook snow looks like.

Pierce and Sartz attended the Eastern Snow Conference meeting at Burlington, Vermont, February 10 and 11. They reported that it was a fine meeting but, ironically, they had to leave early because of a big snowstorm.

Trimble talked to both the New Hampshire Chapter of the S.A.F. and the New Hampshire Resources Planning Board on our watershed program at Hubbard Brook.

Sartz's paper, "Skidroad Erosion--a by-product of mechanized logging" has been submitted to the Northeastern Logger.

Trimble spent several days in the Garlan Brook watershed with personnel of the White Mountain National Forest, planning logging roads which would meet watershed management standards.

PUBLICATIONS

Integrating Timber and Watershed Management in Mountain Areas by Sidney Weitzman and G. R. Trimble, Jr., Jour. Soil & Water Conservation 10:70-75, March, 1955.

DISCUSSION

Effect of a hardwood forest canopy on rainfall intensities. G. R. Trimble, Jr., and S. Weitzman. Trans. AGU: 35:226-234, 1954.

We agree with the Coweeta staff and their reference to Professor Kittredge's text that total interception of rainfall beneath a hardwood stand is greater in summer than in winter, even though substantiating data, cited by Kittredge, are by no means conclusive. Of the two studies he reports, one was very sketchily described and based admittedly on meager data; the other consisted of data the Southeastern Station has never published. In any case there is nothing in our paper which refutes this evidence.

Accepting this evidence does not change our finding that throughfall is reduced by canopy interception approximately the same amount in both summer and winter. If this surprises the Coweeta staff, they are joining good company: it surprised us - and apparently Professor Kittredge was surprised at the relative amounts of winter interception... "... surprising fact is that during the winter deciduous forests without foliage intercept as much of the precipitation as they do."

Coweeta's opinion "... 5 gages at fixed positions and 59 storms cannot provide reliable average figures..." cannot be taken seriously. Differences in average intensities and throughfall were highly significant, a finding which could have well been obtained with even fewer data.

The points on unwarranted extrapolation, the irrational shape of our winter intensity reduction curves, our incorrect expression of the relation of interception rate to ground rainfall intensity, and the nature of the variance of our regression equations were well taken. The Coweeta interception data were interesting in that one of their two examples agreed with our findings.

After studying Coweeta's arguments as to the influence of the forest canopy on erosion, we cannot but acknowledge the points they make - but still consider their influence negligible. To check on this further, we are considering installing paired plots beneath a hardwood canopy, one plot undisturbed, and one with litter removed. The relative contribution towards erosion control of the canopy and litter should become evident. Along these lines, Dunford's data in the December Journal of Forestry are illuminating.

We appreciate Coweeta's comments and look forward to reading any of their findings on this subject.

PACIFIC NORTHWEST FOREST AND RANGE
EXPERIMENT STATION

Watershed Management Research
Semiannual Progress Report, October 1, 1954 - March 31, 1955

General

During the last half year we have continued to stress the need for watershed management research in the Pacific Northwest. Interest continues to grow. Water is a popular subject in this area of hydroelectric power, irrigation, salmon fisheries, and expanding industrial development. It is also wonderful grist for the political mill, and we hear many "grass roots" statements about partnership programs, giveaways, inter-state compacts, and high and low dams. This barrage of mixed fact and opinion fails to hide the gross lack of real information, and many people are beginning to recognize the need for objective and comprehensive study of our water resources.

Cooperative Research in Bull Run Watershed

A plan for cooperative research in the Bull Run watershed is ready for review on April 8 by officials in the Portland Water Bureau. Planned investigations cover a 20-year period at a cost of $12,000 annually plus a total capital investment of $18,400. The objective is to provide a sounder basis for future management of the city's water supply. Since 1892, protection has been the only form of watershed management in this 102-square-mile drainage.

The plan points out two principal problems which can be foreseen:

Need for more water.--Eventually Portland and its environs will need more water, which the Water Bureau is seeking to obtain by creating added reservoir capacity. Our plan points out the alternative possibility of gaining more water by careful cutting of the dense old-growth stand.

Assuring clean water.--Protection of the drainage has been complete only in respect to human disturbance. Natural catastrophes such as fire, insects, disease, and blowdown are

becoming a stronger threat as normal forest uses continue to develop around this isolated body of old-growth timber. More information is needed to determine the possible effect of a sudden destruction of protective cover and the best means of quickly restoring it.

Four studies have been proposed:

Snow storage studies.--Objective: To determine the effect on accumulation and rate of melt from (1) forest openings of various sizes, shapes, and positions; and (2) from snow fences and other types of artificially created barriers.

Runoff studies.--Objectives: (1) To get a more accurate measure of the timing and quantity of streamflow, and (2) to evaluate any increases in water flow which result from cutting for the purpose of adding snow storage and reducing the loss of water to moisture-loving trees and shrubs.

Soil studies.--Objective: To determine the variation in potential erosion hazards based on an analysis of the physical properties of distinct soil types which are possible to delineate on a soil map.

Erosion control studies.--Objective: To develop techniques for minimizing soil erosion and restoring loss of soil stability which may occur from any possible source in the Bull Run watershed.

Blue Mountain Research Center

Some welcome help from the Washington office enabled us to start a small watershed study on the Starkey Experimental Forest and Range last fall. It is designed to determine relative amounts of soil erosion resulting from grazing on six cattle-management pastures. Erosion will be measured in sediment catchment basins, one of which has been constructed in each pasture. Natural watersheds, averaging about 50 acres in area and with a mixed grass and timber cover, drain into the catchment basins.

The test is a supplement to the cattle-management study begun earlier. Next summer, following 2 years of uniform use by cattle, three rates of grazing--light, moderate, and heavy--will be applied on the pastures. For each grazing intensity, two types of cattle management will be tested: (1) season-long, and (2) deferred and rotation. Grazing intensities are expected to

exert the main influence on erosion so that the two management techniques will very likely amount to replications.

Soil disturbance will be evaluated primarily on the basis of sediment caught in the basins. However, supplementary records are planned to determine production and utilization in vegetation and changes in the amount of exposed soil.

Willamette Research Center

The Willamette Research Center was reactivated last fall with headquarters located in the Forestry Building at Oregon State College in Corvallis. Robert H. Ruth is the new leader in charge of research at both Cascade Head and H. J. Andrews Experimental Forests.

Calibration of the experimental watersheds at the H. J. Andrews Experimental Forest continues. We obtained some publicity for this project in a feature article appearing in the Portland Oregonian on March 28. Emphasis was placed on the objectives of the study, particularly the possibilities for increasing runoff by adding to the snow pack and delaying melt.

Miscellaneous Activities

Dunford has discussed the needs for watershed management research before several groups during the past 6 months. Among these are the Portland Chapter of the Izaak Walton League, the Columbia River Section of the Society of American Foresters, Junior Forester Orientation course, Region 6 Advisory Council, and the station's Research Advisory Committee.

In January a report was published by the Governor's Water Resources Committee of Oregon headed by Lyle Watts. It contains an analysis of the status of water resources in Oregon and traces the growing competition for surface and ground water. As an outgrowth of their recommendations, two bills have been presented to the legislature. They are being considered now but have run into strong opposition from some vested interests in water and recreation. One bill calls for creation of a coordinated system of water resources development to be administered by a 7-man board. They will have jurisdiction over water matters now handled by four separate commissions and boards. The second bill establishes a Statewide code for administration of ground water resources. Heretofore there has been no control over use of subsurface waters.

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Division of Watershed Management Research

Semiannual Report -- April 1955

Front Range

In 1938, six small watersheds at the Manitou Experimental Forest were selected to study the influence of ponderosa pine stands on the yield of water. Each watershed was provided with catchment tanks for collecting runoff and sediment. A rain gage network was established.

The six watersheds are contiguous and all drain in a westerly direction. Exposures are predominantly north and south. The soils are developed on an alluvial fan which consists of granitic materials for the most part. The soils along the ridges to about half way down the slopes towards the main drainages of the watersheds exhibit clay pan development in the subsoil; the remainder do not. At the beginning of the investigation, the vegetation consisted of second growth ponderosa pine with a scattering of aspen. The tree crown area occupied from one-half to two-thirds the total area of each watershed and intervening open spots were about one-half covered with native bunchgrasses and low shrubs.

During the summer of 1948, the ponderosa pine trees were removed on four of the six watersheds. An attempt was made to convert two of the watersheds to aspen and brush cover by leaving these species stand during the cutting operations. On the other two treated watersheds, all woody and shrub vegetation was removed, and slash piled and burned in an effort to convert these watersheds to a grass cover.

Because of the rapid response of the native bunchgrass to the removal of the trees, the net result has been the conversion of the four watersheds to a grass cover, with only occasional colonies of aspen and brush. No ponderosa pine reproduction has occurred.

Below is summarized the treatment of the six watersheds:

Watershed designation		Size in acres	Treatment
Block I	A	1.488	Converted to aspen and brush
	B	1.754	None
	C	1.692	Converted to grass
Block II	D	1.775	None
	E	1.035	Converted to grass
	F	1.903	Converted to aspen and brush

Results

Early in the study it was observed that watershed A contributed more runoff and erosion from rainstorms than did the other watersheds. This is shown by the tables which follow. The rainstorms causing runoff and erosion were totaled by years for the months of June to September, inclusive. The mean seasonal totals for the six watersheds are found in table 1.

Table 1.-- Mean seasonal precipitation and runoff for six watersheds during two periods

Period	Watersheds - Block I						Watersheds - Block II					
	A		B		C		D		E		F	
	Ppt.	R/O	Ppt.	R/O	Ppt.	R/O	Ppt.	R/O	Ppt.	R/O	Ppt.	R/O
1940-47	3.85	.0551	3.82	.0128	3.85	.0174	3.85	.0163	3.74	.0226	3.82	.0448
1949-54	1.81	.0515	1.74	.0014	1.82	.0015	1.84	.0012	1.75	.0129	1.77	.0874

The number of rainstorms causing runoff and erosion varied by watersheds as shown in table 2.

Table 2.-- Number of storms causing runoff and erosion from six watersheds

Watershed		Number of storms causing runoff		Number of storms causing erosion	
		1940-47	1949-54	1940-47	1949-54
Block I	A	40	24	22	16
Block I	B	35	11	9	1
Block I	C	34	3	9	1
Block II	D	25	5	7	0
Block II	E	31	10	5	2
Block II	F	19	12	5	1

During the 1940-47 period the average total seasonal rainfall (June to September) which caused runoff amounted to 3.82 inches, while for the 1949-54 period it was 1.79 inches. Average total seasonal runoff for the two periods amounted to 0.0281 and 0.0260 inches, respectively. Comparisons of these averages of rainfall and runoff indicate a greater percentage of runoff during the 1949-54 period (1.45 percent vs. 0.73 percent) than previously and that this increase may be attributed to the removal of the tree cover on four of the watersheds.

Erosion caused by the rainstorms is very erratic for the six watersheds and for the two periods. In table 3 the total amount of erosion is summarized for the six watersheds for the two periods.

Table 3.- Total erosion in pounds from the six watersheds

Period	Watersheds - Block I			Watersheds - Block II		
	A	B	C	D	E	F
1940-47	6,712.35	179.02	149.97	229.45	5.74	11.87
1949-54	5,273.19	1.80	3.00	0	10.29	7.60

The erosion data from the six watersheds are too scant and sporadic for an analysis of the effects of treatment. In addition, the amount of seasonal rainfall has on the average been about 2 inches less during the 1949-54 period than formerly, and thus a dependable test of the effects of treatment of erosion cannot yet be made.

Analysis of results

The runoff data do provide a basis upon which to evaluate treatment effects. The evaluation is based on the relation between total seasonal rainfall and runoff for each of the years of the 1940-47 and 1949-54 periods.

The analysis of treatment effects was first based on the relation between the rainfall and runoff occurring on the six watersheds during the 1940-47 period. It was observed from the data that the greater the rainfall the greater the runoff, and vice versa. Accordingly, the regression equation which follows was fitted, by least squares, to the data as a means of estimating runoff from rainfall.

$$\hat{y} = 0.01028x - 0.0112$$

where;

$\hat{y}$ = estimated runoff

x = total seasonal rainfall

The correlation coefficient between rainfall (x) and runoff (y) was 0.7671, highly significant. In the regression equation the coefficient (b) for x is also highly significant and the standard error of estimate is 0.0283 inch. The equation appeared sufficiently reliable on which to base estimates of runoff.

The second step in the test of treatment effects embodied an analysis of variance of the differences between the actual runoff which occurred on the six watersheds during each of the years of the 1949-54 period and the estimated runoff for the same watersheds as determined through the use of the regression equation. Significant differences between the actual and estimated values of runoff would lead to the conclusion that treatment did have an effect, while non-significant differences would point to no treatment effects.

In table 4 are summarized the differences between the mean actual and estimated values of runoff for the 1949-54 period.

Table 4.-- Differences in mean values between actual and estimated runoff for six watersheds 1949-1954

	Watersheds - Block I			Watersheds - Block II		
	A	B	C	D	E	F
	Inches			Inches		
Actual	0.0515	0.0014	0.0015	0.0012	0.0129	0.0874
Estimated	.0073	.0067	.0075	.0077	.0068	.0070
Difference	.0442	-.0053	-.0060	-.0065	.0061	.0804

As expected, the estimated values, based on rainfall and runoff records for the 1940-47 period, are relatively uniform. Watersheds A, E, and F show differences in excess of the estimated values while watersheds B, C, and D exhibit negative values. This indicates a treatment effect for the former three, but not for the latter. As watersheds B and D were not treated, this is not surprising. It appears that treatment did not affect the rainfall-runoff relations of watershed C during the 1949-54 period. When the mean runoff difference of the untreated watersheds, -0.0059 inch, is contrasted to the mean runoff difference of the treated watersheds, 0.0311 inch, the effect of treatment on runoff is pronounced for the 1949-54 period.

The analysis also showed that there were significant differences between the watershed means, between the yearly means, and between the block means. The difference between the block means may be explained by the fact that watershed C, Block I, did not respond to treatment and tended to act as another control. This was not the case in Block II as both treated watersheds responded to timber removal.

The significant differences for both the watershed and yearly means are illustrated qualitatively in tables 5 and 6.

Table 5.-- Significance of differences in watershed means

Watersheds	Watersheds			Watersheds		
	A	B	C	D	E	F
A	-	S	S	S	S	S
B	S	-	NS	NS	S	S
C	S	NS	-	NS	S	S
D	S	NS	NS	-	S	S
E	S	S	S	S	-	S
F	S	S	S	S	S	-

S = Significant to 5 percent level or better.
NS = Not significant to 5 percent level.

Table 6.-- Significance of differences in yearly means

Years	Years 1949	1950	1951	1952	1953	1954
1949	-	S	S	S	S	NS
1950	S	-	S	S	NS	S
1951	S	S	-	NS	S	S
1952	S	S	NS	-	S	S
1953	S	NS	S	S	-	S
1954	NS	S	S	S	S	-

S = Significant to 5 percent level or better.
NS = Not significant to 5 percent level.

Summary

On four of the six small watersheds ponderosa pine trees were removed to encourage the growth of grass and to determine the effects of tree removal on runoff and erosion from rainstorms occurring from June to September, inclusive. Only the runoff data were adequate upon which to determine treatment effects. A longer period of record will be required before sufficient erosion data are obtained.

Through the use of a regression equation based on seasonal rainfall and runoff records for the 1940-47 pretreatment period and an analysis of variance between the actual and estimated values of runoff for the treatment period, 1949-54, the effects of treatment were determined for the six small watersheds.

For the 1949-54 period, the runoff from watersheds A, E, and F differs significantly from watersheds B, C, and D, and from each other. Treatment has affected the rainfall-runoff relations of the former three watersheds when compared to the 1940-47 pretreatment period. The remaining three watersheds are similar in their runoff characteristics for the 1949-54 period, indicating that treatment has had no effect on their rainfall-runoff relations. This is not surprising for watersheds B and D which were not treated, but it was unexpected for watershed C which was treated.

Fraser Hydrologic Laboratory

The past 6 months have been largely devoted to "deck clearing" activity in preparation for the initiation of new studies. Accumulated climatic, streamflow, and soil moisture data are being compiled and studied to enable conclusions on the effectiveness of past instrumentation and to allow the use of all existing information in the planning of new studies of snow accumulation and melt as affected by timber management.

An illustration gleaned from that old standby, the Wagon Wheel Gap report, points up the importance of considering aspect and slope when planning tests of timber removal effects on snow sublimation and melt. At this latitude, south-facing slopes, not unusually steep, receive as much solar radiation per unit slope area during spring and summer as does a level area at the equator. A similar but north-facing

slope receives less direct sunlight during the same period than does a level surface near the North Pole. Thus, across an east-west valley we have differences in solar radiation as great as those between areas on the equator and areas north of the Arctic Circle. Since the Rockies insolation is believed to be the chief factor in snowmelt, these differences are of great importance to watershed management research. At Fraser, a reputedly cold spot, snow on south slopes disappears several weeks before that on north slopes and probably melts on many winter days.

Discussion of trough-type rain gages, by B. C. Goodell

Trials of trough-type rain gages were reported by the Kingston Research Center in the last semiannual report. Some deficiencies in the catch of hemi-cylindrical gages were noted, and also a correlation between deficiencies and degree of slope of the gage. It was stated that in theory such a gage would not allow splash-out.

To me, this faith in the hemi-cylindrical shape seems misplaced in view of the fact that rain falling vertically into a level or slightly sloping gage will strike along the center line of the gage at such an angle that high splash is to be expected. Some splash-out would be certain, I would think, when a shallow layer of water accumulates in the gage. It also seems likely that slanting rain would be reflected from the sides of the trough in such directions as to result in some splash-out.

Could the lesser deficiency in more steeply sloping gages be attributed to the direction of splash to be expected? The steeper the slope of the gage, the more directional should be the splash--the more the splash "downhill" and the less the random lateral splash. The downhill splash will result in splash-out at the lower end of the gage, but if the gage is long, the loss here might be less than from a less steeply sloping gage that suffered more lateral loss.

Experience here has indicated that screens may be used satisfactorily to prevent significant splash-out from shallow trough gages. In extensive laboratory tests of the type FA infiltrometer, a screen adequately prevented splash-out from a pan 3 inches deep, 1 foot wide, and 2-1/2 feet long. (The application and measurement of artificial rainfall on types FA and F infiltrometers. H. G. Wilm, AGU Transactions, 1943, Part II, pp. 480-486.) Trough gages 3 inches deep, 3 inches wide, and approximately 16 inches long, were used extensively in one field study and were similarly protected against splash loss. In each case, wire screen cloth was mounted at a height of about 1 inch above the pan bottom.

Tempe

This is the time for streamflow forecasts and we, like many others, take a try at it. Estimates of the flow of Salt River for the period March 1 to May 31 are determined by two different methods: (1) Correlation between Parker Creek streamflow from October 1 through February 28 and Salt River streamflow from March 1 through May 31; and (2) correlation between the streamflow in Salt River from October 1 through February 28 and streamflow in Salt River from March 1 through

May 31. The estimate based on previous streamflow from Parker Creek was 101,600 acre-feet (34 percent of average for the 20 years of record available), and the estimate based on previous streamflow from Salt River was 105,800 acre-feet (46 percent of average for the 41 years of record). The big question now is how close the estimates are.

The average water content of the snow courses on Salt and Tonto Basins was 26 percent of normal as of March 15, 1955, according to the Federal-State Cooperative Snow Survey and Water Supply Forecasts for Arizona. Precipitation at Workman Creek has been approximately 50 percent of average for the October through February period. Thus the drought continues in the Southwest.

Reservoir storage on the Salt River is 790,000 acre-feet -- 110 percent of the 10-year average but only 45 percent of capacity.

If we consider drought as some combination of weather conditions that restricts moisture availability for plant growth, then the 1953-54 water year was not a drought year in this part of Arizona. Precipitation at Workman Creek for the summer growing season was 185 percent of the longtime average, and for Sierra Ancha headquarters 134 percent of the longtime average.

However, if we consider drought as some combination of weather conditions that restricts the flow of streams, then the 1953-54 water year might be considered a drought year. Salt River contributed 346,000 acre-feet to Roosevelt reservoir compared to an average annual flow for the period 1913 to 1950 of 664,000 acre-feet. The 1953-54 water yield of Workman Creek, on the other hand, was 2.74 inches. This compares with the 16 year average of 3.39 inches. While 2.74 is below the 16-year average, it is almost exactly median for the period of record, being overbalanced by 2 high years of flow out of the 16 years of record.

It is interesting to note that in Workman Creek in 1940-41 when the highest annual streamflow and the highest annual precipitation ever recorded in Workman Creek occurred, the summer rainfall was next to the lowest on record, exceeded only by 1948. In the second highest streamflow year, 1952, summer rainfall was almost exactly average. Thus, streamflow may well serve as an index of drought for the irrigated valley, but may be entirely wrong as an index of moisture availability for plant growth on the watersheds. And similarly, precipitation may well serve as an index of drought for the growth of plants but may be entirely wrong as an index of streamflow conditions.

A determination of whether a condition of drought exists or not depends on more than precipitation and streamflow. For example, an irrigation project optimistically designed to use more than the average streamflow could experience chronic drought even though precipitation and streamflow approach the average each year.

Preliminary records of cutting the broadleaf species on North Fork of Workman Creek show no significant changes in streamflow

The first cutting treatment was completed on the North Fork watershed of Workman Creek in August 1953. This cut removed all broadleaf species, such as alder and maple that require large amounts of water during the growing season, growing along the living streams or immediately in or adjacent to seeps and springs.

One hundred fifty-eight alders (Alnus oblongifolia), varying in size from 1 to 33 inches, and 946 maples(Acer grandidentatum), varying in size from 1 to 11 inches, were cut and left on the forest floor. The total basal area of these trees was 271 square feet, and was approximately 0.6 percent of the total basal area of all species in the North Fork watershed or the trees from about 1-1/2 acres out of the 248-acre watershed.

Streamflow records for the 1953-54 water year (October 1, 1953 to September 30, 1954) showed no increase or decrease in annual water yield. The "F" value from the covariance analysis was 0.015 and 4.75 would be required for significance at the 5 percent level.

Precipitation and streamflow were not average during 1953-54. The winter was dry until March. During March more than 12 inches of moisture was recorded and about two-thirds of the year's water yield was measured in this 1 month. Both winter precipitation and winter streamflow were below average.

Summer rainfall was 185 percent of average and summer yield was the third highest since 1939. The 7 days of highest water yield produced nearly one-third of the total summer flow for the 4-month period June through September.

This precipitation and runoff pattern could have masked the changes in water yields that may have resulted from the cutting treatment and that may show up in another year of more nearly average conditions. On the other hand, it may be that removing less than 1 percent of the basal area of a watershed will not result in significant changes in water yields even though the trees cut are water-loving species.

Grand Junction

Badger Wash Cooperative Study

Initial infiltration and erosion measurements at Badger Wash were completed in October 1954. These were made as part of a cooperative study to determine the effect of livestock exclusion on erosion and runoff in the salt desert shrub type. The average results of the 1953 and 1954 tests are as follows:

Average infiltration rates for last 20 minutes of tests

Soil derivation	Average infiltration rate (inches/hour)	
	Dry runs	Wet runs
Shale	0.62	0.56
Mixed shale and sandstone	.87	.69
Sandstone	2.38	1.45

Average erosion rates from infiltrometer tests

Soil derivation	Erosion rate (tons/acre/inch surface runoff)	
	Dry runs	Wet runs
Shale	4.22	3.20
Mixed shale and sandstone	3.03	2.28
Sandstone	.78	.70

The data are being analyzed statistically in order that initial differences in infiltration and erosion characteristics may be established.

Initial ground cover was measured in 1953 and summarized in the semiannual report for October 1953-March 1954. In 1958 and at subsequent 5-year intervals further measurements of vegetation, infiltration, and erosion are planned in order to determine relative changes which occur on grazed and ungrazed watersheds.

Southeastern Forest Experiment Station
QUARTERLY PROGRESS REPORT
October - December 1954

DIVISION OF WATERSHED MANAGEMENT RESEARCH

SUMMARY

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Effect of Cutting Cove-Site Vegetation Upon Soil Moisture

Where vegetation has been cut on Coweeta watersheds what changes in soil moisture can be expected is a question frequently raised by visiting technicians. One treatment recommended in the 1953 Program Conference was to determine the effect of cutting the cove-hardwood forest type on water yield. During March and April all shrubby and tree vegetation growing in the cove-hardwood type was cut or girdled and treated with Atlas "A". To measure changes in soil moisture transects extending from the creek channel up the slope into the oak-hickory forest type were established on the control and treated watersheds. Gravimetric sampling stations were established at 33 foot and 66 foot intervals along each of the transects. Preliminary results from data processed this quarter are reported in Table 1 for one pair of transects. Both transects had similar amounts of total soil moisture in April. When sampling stopped August 28 the untreated cove-site area had been reduced 7.20 inches while the treated area changed only 1.20 inches. For these deep, well drained soils gravimetric equipment limited routine sampling to 7 feet. Since a few roots were observed below the 7 foot level, plans for the next season are to measure changes in the entire soil mantle.

Table 1.--Comparison of total soil moisture as measured on a pair of transects in a cove-hardwood site having deep, well drained soil

Depth	Control watershed			Treated watershed		
	April 28	August 31	Change	April 28	August 31	Change
Feet	Inches	Inches	Inches	Inches	Inches	Inches
0- .5	1.90	1.22	- .68	1.86	1.72	-.14
.5 - 1	1.96	1.19	- .77	1.87	1.44	-.43
1 - 2	3.46	2.64	- .82	3.58	3.07	-.51
2 - 3	3.81	2.89	- .92	3.71	3.62	-.09
3 - 4	3.59	2.31	-1.28	3.51	3.69	+.18
4 - 5	3.49	2.34	-1.15	3.19	3.03	-.16
5 - 6	3.37	2.37	-1.00	3.42	3.42	0
6 - 7	2.30	1.72	- .58	2.42	2.37	-.05
	23.88	16.68	-7.20	23.56	22.36	-1.20

Effect of Forest Cuttings on Stream Temperature

A watershed experiment was carried out this year in which all tree and shrubby vegetation growing in the cove-hardwood forest type was deadened. Approximately 10 acres of cove-site vegetation was killed by girdling and silvicides on the 40-acre watershed. One of several values measured in this study was stream temperature on the treated watershed and on an adjacent control watershed of 30 acres. At a fixed station in rapidly flowing water weekly maximum and minimum temperatures were collected on both watersheds for one year in 1947. These stations were reactivated in March 1954. Treating the cove-site vegetation started in March and was completed April 9, 1954.

During the first growing season of this treatment mean maximum temperatures sustained a significant 2-degree rise, Table 2. The mean monthly minimum temperatures do not show any definite trend. Removal of cove-site vegetation along the 1250 feet of stream channel indicated water temperatures can be closely correlated with air temperature. During the pretreatment period instantaneous maximums were 66° on both watersheds. This year maximum temperatures increased to 70° on the treated watershed with no change on the control. From all watershed treatments involving timber cutting at Coweeta the data suggest that considerable manipulation of crown canopy vegetation can take place before water temperatures increase above limits of tolerance for trout.

Table 2.--Comparison of average monthly maximum stream temperature for an undisturbed control and for a watershed on which cove-site vegetation was cut following pre-treatment operations

(Maximum stream temperature expressed in degrees F.)

Month	1947 Before			1954 After		
	Control	Treatment	Diff.	Control	Treatment	Diff.
April	56	56	0	56	57	+1
May	57	57	0	57	57	0
June	61	60	-1	60	63	+3
July	61	61	0	65	67	+2
Aug.	64	64	0	64	68	+4
Sept.	65	64	-1	63	67	+4
Oct.	59	60	+1	60	62	+2
Nov.	53	52	-1	51	54	+3
Aver.	59.5	59.3	1/ -2	60	62	2/ 2

1/ Difference not significant
2/ Difference significant at 1 percent level.

Discharge Integrator

A discharge integrator purchased from the Surface Water Branch of the U. S. Geological Survey was received in November. The machine was to have been tested before shipment, but considerable checking and adjustment was necessary before it could be used. As mentioned in the January-March 1953 Quarterly Report, we have found Integrator No. 49 to be the more accurate than previous procedures and that it reduces computing time 75 percent. The present rate of integrator computations on FW-1 curvilinear charts is one month per man hour. However, we wonder why a machine with so few moving parts should cost $1711 in comparison with standard office machines and complex laboratory equipment.

Further Studies on the Water Balance

Retention storage capacity of the Coweeta watersheds usually plays its most visible role in the water balance during the months of October, November and December. Precipitation during this fall period may have little effect on increasing baseflow of streams. The current precipitation obviously goes into retention soil moisture to satisfy the deficit created during the growing season. A good example occurred this fall when, as reported in the July-September report, vegetation was affected by lack of soil moisture and streams registered record low flows. Over 5 inches of rain in October and November did not raise baseflow of streams.

Ordinarily, recharge to ground water does not occur until the retention storage deficit is first reduced to zero. Under natural conditions at Coweeta complete recharge does not occur simultaneously throughout a whole watershed, but is extremely variable, particularly when the fall rains are small. For example, it has been observed that some areas will be at field capacity down to the water table, and during storms there is accretion to the ground water table, while other areas are at various stages approaching this condition.

To estimate the operating range in retention storage on a watershed basis it is proposed to use the water balance equation as follows:

$$\Delta R = P - (I + E_1 + RO + \Delta D)$$

where ΔR = difference between initial and final values of retention soil moisture

ΔD = difference between initial and final values of ground water

P = Precipitation

I = Interception

E_1 = Evaporation

The equation has been applied to Watershed No. 2 for October-December, the period of soil moisture replenishment. The change in retention storage ΔR, as obtained, is a field value which will vary from year to year. It represents the accretion from the September 30 deficit to approximate field capacity. It does not correspond to the total available water for plant growth between field capacity and wilting point.

The water balance as shown in Table 3 is for those years having a fairly steady depletion of ground water in the growing season. The minimum flows in Column 1, Table 3, indicate the extent of summer depletion. An assumption was made that for soil moisture replenishment to be complete over the entire watershed only those years when water storage had increased approximately 1.0 area inches during the October and November period would be used.

Table 3.--Soil moisture retention storage for Watershed No. 2

(Estimated from water balance equation period Oct. 1-Nov. 30)

Year	Date	Minimum flow	Precipitation	Interception	Evaporation	Runoff	Accretion to ground water	Accretion to soil moisture
		C.s.m. (1)	Ins. (2)	Ins. (3)	Ins. (4)	Ins. (5)	Ins. (6)	Ins. (7)
1935	Oct.23	.24	12.50	1.27	3.00	1.83	0.40	6.00
1936	Sept. 19	.30	18.80	2.20	3.00	3.50	1.50	8.60
1937	Oct. 1	.36	16.56	1.94	3.00	2.95	1.40	7.27
1941	Oct. 25	.13	14.82	1.83	3.00	1.94	.85	7.20
1944	Nov. 11	.20	12.67	1.47	2.00	1.22	.80	7.18
1947	Oct. 6	.27	18.99	2.14	3.00	3.65	1.18	9.02
Average								7.55

Interception in Column 3 was obtained from a linear relation for a Southern Appalachian hardwood forest. The fixed evaporation amounts, Column 4, were estimated using various sources of information. Transpiration during the dormant season is negligible or zero. Changes in ground water storage, Column 6, were obtained by using the storage discharge curve.

From the values in Column 7 it appears that the estimated average retention storage capacity of the watershed above the normal summer point is 7.5 inches of water.

Figure 1 illustrates the pattern of ground water recharge for the whole season and for shorter intervals as September 19 to October 5, 1936. For this short interval the retention capacity is 5.9 inches. The value is less than the 7.6 inches in Table 3 due to the fact that soil moisture replenishment is not complete over the entire watershed.

It is reasonable to assume from these results that each year soil moisture storage capacity on Watershed No. 2 operates in the neighborhood of 7.0 inches. Total retention storage is larger than this amount. Allowing mainly for interception, one large storm around 8 inches should, in a normal year, bring most of the watershed up to field capacity. When storms are small and scattered with opportunity for ground evaporation it may perhaps take 16 inches of rainfall to satisfy retention storage.

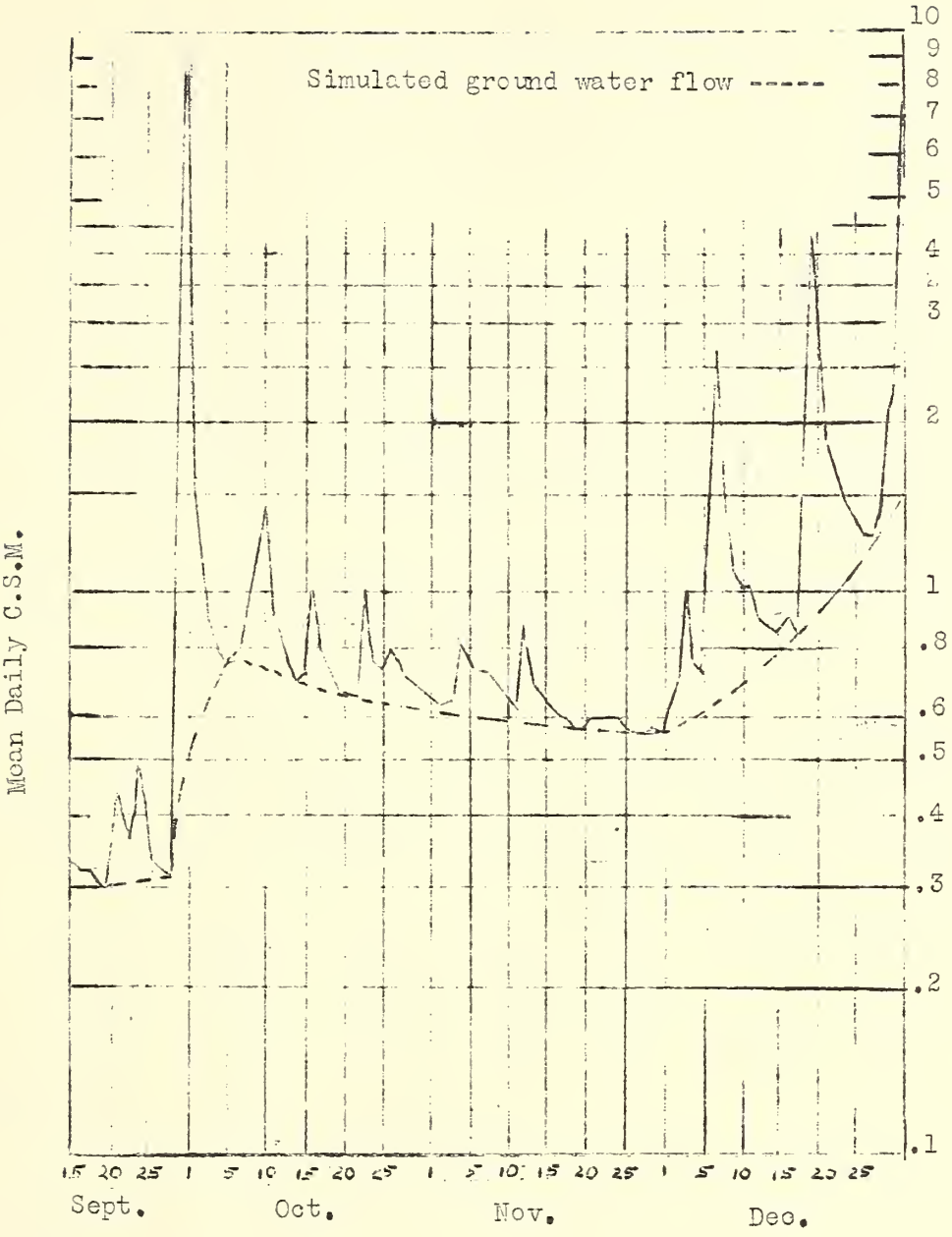

Figure 1.--Stream hydrograph, 1936. Watershed No. 2.

The Circular Normal Distribution

The circular normal distribution has been developed by Gumbel, Greenwood, and Durand (1) as a distribution function applicable to recurrant phenomena having a known period. The function is, therefore, of particular value for climatological and hydrological data which are known to have an annual cycle and may be expressed in 12 monthly values or frequencies. Gumbel (2) has given many practical applications which illustrate the merits of the function.

The histogram in Figure 2 consists of adjusted mean monthly runoff values from Watershed No. 18 for the 17-year period 1936-1952. These values are adjusted to a 360 day year consisting of 12 equal months and adjusted again to conserve the annual total. The frequencies represented by the monthly amounts of runoff illustrate one kind of time series suitable for analysis. The mode occurs in March and the anti-mode in September. For this example it happens that runoff for September is greater than the October, so that distribution is not symmetrical.

Table 4.--Monthly runoff Coweeta Watershed No. 18
Period 1936-1952

(In inches)

Month	Frequency: observed	1st. Adj.	2nd Adj.	Month	Frequency: observed	1st Adj.	2nd Adj.	Theoretical Rate
Mar.	6.41	6.201	6.29					6.06
April	5.08	-	5.08	Feb.	5.44	5.829	5.90	5.45
May	3.68	3.560	3.60	Jan.	4.44	4.295	4.35	4.07
June	2.36	-	2.36	Dec.	2.71	2.622	2.65	2.73
July	1.99	1.925	1.95	Nov.	1.67	-	1.67	1.83
Aug.	1.69	1.635	1.65	Oct.	1.23	1.190	1.20	1.36
				Sept.	1.45	-	1.45	1.22
					38.15	3.782	38.15	38.16

The theoretical values of the distribution are computed by procedures developed in reference (1) and (2). The values are plotted as the smooth curve in Figure 2. The fit is not too good for this particular example, and at present there is no test for goodness of fit.

(1) Gumbel, E. J., Greenwood, J. A., and Durand, D.
The Circular Normal Distribution: Theory and Tables, Jour. Am. Stat. Assn. Vol. 48: 131-151, March 1953.

(2) Gumbel, E. J.
Applications of the Circular Normal Distribution. Jour. Am. Stat. Assn. Vol. 49: 267-297, June 1954.

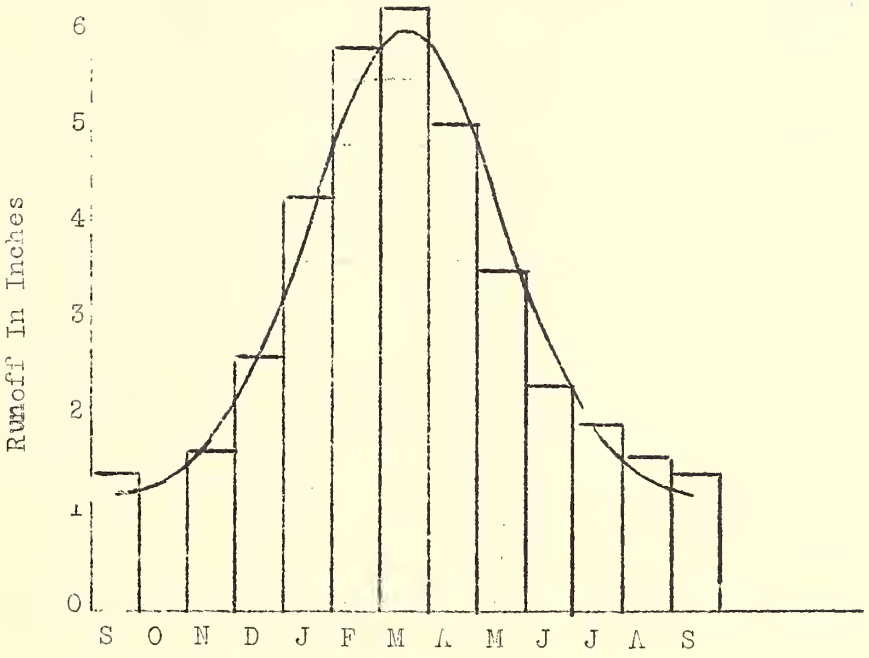

Figure 2.--Monthly mean runoff - Watershed No. 18
1936-1952

The main reason for this brief article is not to demonstrate this new function, which is adequately described in the foregoing references (1) and (2), but to suggest that it will be used with caution even when the fit appears satisfactory. The circular normal distribution is symmetric about the modal-antimodal axis. It is rather remarkable that the monthly runoff distribution in Figure 2 exhibits so much symmetry, considering the annual rainfall pattern.

Coweeta Hydrologic Notes

The precipitation deficiency for July-September which amounted to 6.80 inches continued through this quarter until the last week in December when the accumulated deficit was 11.5 inches. A heavy rainfall totaling 6.07 inches after December 28th halted this dry trend and restored the last quarter precipitation to normality. Precipitation for the water and calendar years was below normal, Table 5. During the quarter snow flurries were quite frequent and at one time there was appreciable snow at the higher elevations.

Table 5.--Precipitation summary

Month (1954)	Precipitation	Deviation from normal	No. of storms	Deviation from normal
October	0.87	-2.59	12	-7
November	4.70	-0.45	6	+3
December	10.35	+3.22	9	-4
Quarterly Total	15.92	+0.18	27	-8
Water Yr. to Oct. 31	65.61	-3.75		
Water Yr. 1955 to Dec.31	15.05	+2.77		
Calendar Year	66.60	-2.78		

Air temperatures were generally below normal for the last quarter, Table 6. Cold weather persisted for extended periods, with a few storms moving into the area from the Gulf of Mexico bringing higher temperatures.

Table 6.--Climatic summary of air temperatures and evaporation

Month:	Average		Maximum		Minimum		Evaporation	
	1954	Dev.from: normal	1954	Dev.from: normal	1954	Dev.from: normal	1954	Dev.from normal
	°F	°F	°F	°F	°F	°F	In.	In.
Oct.	55.2	-0.8	70.8	-0.1	39.6	-1.6	2.89	+ .32
Nov.	42.1	-3.0	55.9	-2.7	28.3	-3.1	1.32	- .37
Dec.	37.2	-2.3	48.2	-3.1	26.2	-1.1	1.30	+ .25
Aver.	44.8	-2.0	58.3	-2.0	31.4	-1.9	1.84	+ .07

It is interesting to note that minimum air temperatures show a greater range than the maximums. Part of this is attributed to location of the weather station in a frost pocket on the Administrative Area. Ordinarily the greatest variation would be the minimums.

Table 7.--Range of maximum and minimum air temperatures

October - December 1954

	October		November		December	
	Min.	Max.	Min.	Max.	Min.	Max.
Low	20	41	7	39	8	31
High	62	86	50	70	54	60
Range	38	45	43	31	46	29

Due to lack of rain, soil moisture was replenished slowly during the quarter. October and November contributions to soil moisture were negligible. Observations of soil moisture during trail construction as well as streamflow suggest that the December 27 storm was responsible for bringing the entire soil profile to field capacity.

Extremely low streamflow and groundwater tables persisted throughout most of the quarter. Many wells in the county went dry and remained so until the December 27 storm. Table 8 shows some instantaneous minimum flows on watersheds of varying elevation.

Table 8.--Minimum instantaneous flows

Watershed	Mean elevation	Discharge
	Feet	C.s.m.
2	2825	0.08
22	3434	0.35
27	4155	0.16
36	4245	0.47

The Coweeta guidebook, on page 9, lists minimum flows as observed on gaged watersheds. Table 9 lists new minimum flows observed this fall.

Table 9.--Record minimum flows established 1954

Watershed	Discharge	Watershed	Discharge
	C.s.m.		C.s.m.
2	0.08	27	0.16
7	0.48	28	0.53
14	0.38	36	0.48
18	0.27	37	0.31
19	0.67	41	0.48
22	0.35	12	0.44

Cooperation

Arrangements were completed with the University of Georgia School of Forestry for Coweeta's 10th graduate thesis project. Leroy Jones, a former cooperative forestry student, started field work on his Masters thesis during the Christmas holidays.

Kenneth Pitcher, graduate student in Forestry at N. C. State College, spent December 20-January 4 processing streamflow data for his Masters thesis. He plans to have the thesis completed by May 5, 1955.

Inquiries, Consultation, Visitors

A helpful Program Conference was held at Coweeta November 29 to December 3 to review research needs, techniques, and priorities with respect to the basic hydrology phase of the Coweeta program. Participating were Storey and Osborne (Washington Office); Lull (Northeastern Station); Whelan (R-7); Horton (Vicksburg Infiltration Project); and Meginnis, Johnson, Kovner, Evans and Metz from the Station.

Extending of the Water Facilities Act to the Eastern States and passage of Public Law 566 during the 83rd Congress, plus critical water shortages in the Southeast have greatly increased inquiries about watershed management and work of an S & PF nature. During the last year over 100 technical inquiries were handled on a consulting basis or by correspondence.

The local SCS District has asked help in preparing preliminary plans for an application for planning assistance under Public Law 566. Tentative plans are for a 90,000 acre watershed project on the Little Tennessee River above Prentiss, North Carolina. If local people organize and surveys indicate the Little Tennessee appears to be a promising project, Coweeta would be strategically located with reference to flood prevention activities and efforts to evaluate them.

The heavy visitor load continued this quarter with 19 groups and a total of 88 people being shown around the Laboratory. A week's training session was provided Robert Pierce, a Northeastern Station transferee.

Publications

Williams, Jerry, G.
A study of the effect of grazing upon changes in vegetation on a watershed in the southern Appalachian Mountains.
Jour. of Forestry, 52(11), November 1954.

PIEDMONT RESEARCH CENTER[1/]

October - December 1954

The hot dry weather of summer continued into October with the precipitation that month the lowest recorded on the Calhoun to date. Precipitation for 1954 totaled 33.08 inches. This was 14.50 inches lower than the 50-year average for a nearby Weather Bureau station.

Quarterly Climatic Summary - Calhoun Experimental Forest

Month	Average temperatures: Max.	Min.	Mean:	Highest: temp.	Lowest: temp.	No. of days: with rain	Precip.	Evap.
	°F	°F	°F	°F	°F		Inches	Inches
Oct.	81	45	63	100	24	2	0.62	5.02
Nov.	59	33	46	72	17	12	2.95	1.84
Dec.	54	27	40	71	12	9	3.24	1.51

Loblolly Pine Seed Source Plantings

Loblolly pine from nine geographic seed sources ranging from Maryland to Mississippi were planted on the Calhoun Experimental Forest in March 1950. This planting is one of several established in cooperation with the Tennessee Valley Authority to test the variation of plantings of different seed sources in different locations, and demonstrate contrasting development of plantings in a single locality. The seedlings used in this planting were one-year-old and were raised in TVA nurseries.

The data from the fifth-year remeasurement are summarized in the table below for eight of the nine seed sources. The other seed source, from North Carolina seed, failed during the first growing season. This source was replaced with a South Carolina source which also failed. Then in 1952 seedlings from a second South Carolina source were planted, and the third-year measurements for these trees are included in the table.

The Nantucket pine tipmoth, Rhacionia frustrana, has done considerable damage to the plantings. In nearly all of the sources there is a high percentage of infestation. The ultimate effects of this damage may or may not be serious.

1/ Joint projects of the Divisions of Watershed Management and Forest Management.

Considering all the factors, the North Alabama, Georgia, and South Alabama sources show the best five-year results; while the North Mississippi and Virginia sources show the poorest five-year results.

Summary of survival, total height, and tipmoth[1/] damage of loblolly pine from selected seed sources planted on the Calhoun Experimental Forest

Seed Source		Average Survival	Average Total Height	Trees showing tipmoth damage
Number	State	Percent	Feet	Percent
1	Alabama, north	93.75	10.65	42.2
2	Alabama, south	95.83	8.90	73.9
3.	Georgia	95.83	9.30	67.4
4	Maryland	72.92	8.23	68.6
5	Mississippi, east	75.00	8.98	75.0
6	Mississippi, north	70.83	8.21	82.3
8	Tennessee	66.67	8.12	90.6
9	Virginia	68.75	8.78	57.6
17 [2/]	South Carolina	62.50	4.72	93.3

1/ Nantucket pine tipmoth, Rhyacionia frustrana.
2/ 1-0 stock planted in March 1952.

Humus Types

On the Calhoun Experimental Forest there are three areas, each about 15 acres, known as the stand conversion compartments. One is being managed for pure shortleaf pine, one as a pine-hardwood mixture, and one as hardwood. The object of this long-term experiment is to determine the effect of changing the plant cover upon soil properties and the littleleaf disease of shortleaf pine. Intensive pretreatment data have been collected on the vegetation, soils, Phytophthora cinnamomi, and humus types. This report is concerned with the humus types in the three compartments. The findings of the survey, which included observations of 134 pits, follow:

Humus Type*	Composition of Litter			Total
	Pine	Pine & Hardwood	Hardwood	
Imperfect Mor	22	1		23
Thin Mor	30	7		37
Felty Mor	2	1		3
Greasy Mor		1		1
Thin Duff Mull	2	24	18	44
Sand Mull	4	4		8
Medium Mull		9	9	18
Total	60	47	27	134

* Types identified according to description in Humus key produced by Committee on Soil Humus Types of the Forest Soils Division of the Soil Science Society of America.

On these areas the important factor contributing to the organic layers is the vegetation. The forest floor is dependent on the completeness of the canopy, and the quantity and decomposition rate of material added to the soil surface.

In the mor types, found mainly on areas of pine litter, the organic material decomposes slowly and mixes little with the mineral horizons. Of the 60 pits under pine litter, all but six were mors. When a portion of the litter consists of more rapidly decomposing hardwood species, a humus layer like that found beneath the pines is formed, and some material also moves into the surface mineral soil forming an A_1 horizon. Of the 47 pits in pine-hardwood litter, all but 10 had an A_1 horizon. When the litter consists entirely of hardwood leaves then an A_1 is usually formed; in the 27 pits in hardwood litter all had an A_1 horizon.

Although topographic position affects the organic layers, this feature was confounded with vegetation. The ridges and upper slopes were pure pine, the middle slopes mixed stands, and the lower slopes and bottoms, hardwoods.

The texture of the surface soil is also a factor in determination of humus types. However, the whole area covered in this survey had a surface layer of sandy loam.

More and more interest is being shown in forest soils at the present time. The type of forest floor is important because it is the one phase of forest soil which can be altered by the forest manager in a relatively short time. Copies of the "Key for Classification of Forest Humus Types" as published in the Soil Science Society of America Proceedings are available at the Piedmont Research Center. We would appreciate knowing of any areas where the key does not seem to apply.

General

A field day was held on October 8 for state forestry personnel and extension foresters from North Carolina and South Carolina. About 25 attended.

Metz, as Station representative, attended the annual meeting of the North Carolina Forestry Association in Winston-Salem, N. C., November 16-17.

A program conference at Coweeta was attended by Metz from November 30 to December 3.

The Center was visited by GI inspectors Cliff and Josephson of the Washington Office on October 20-21; and a functional inspection of forest management work was made by Lexen (Washington Office) and Tom Evans on November 29-30. An internal audit was also made by Wilmoth (R-8) and Hunnicutt on December 7-8.

Southeastern Forest Experiment Station
QUARTERLY PROGRESS REPORT
January - March 1955

DIVISION OF WATERSHED MANAGEMENT RESEARCH

SUMMARY

Coweeta Hydrologic Laboratory

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Timber sale made on Watershed 41	H 1
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Piedmont Research Center

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Southeastern Forest Experiment Station
QUARTERLY PROGRESS REPORT
January - March 1955

DIVISION OF WATERSHED MANAGEMENT RESEARCH

COWEETA HYDROLOGIC LABORATORY

General

A combination of the heaviest I and E workload ever experienced during the winter season plus lack of non-technical manpower made for slow progress on analysis of research data this quarter. It was necessary for Kovner and Johnson to spend considerable time on the following operational activities.

1. Reviewing some of the back streamflow and precipitation records for selected watersheds to check and assure reliability of the data. For some watersheds where it was desirable to check water yield on a monthly basis, integrator techniques were devised for processing 12 months of streamflow data in 5 to 6 hours. We are studying procedures for reducing posting errors in the various steps now being used for processing precipitation data.

2. Continuing the program for field checking of the weir blade rating for all Coweeta installations. The 120° weir blade rating curves derived under flows experienced to date check closely with those published by Hertzler in 1938.

3. On Watershed 22 a 100-percent cruise of all stems 0.5" d.b.h. and larger was made by species for all vegetation except laurel and rhododendron. The Wayah District of the North Carolina National Forests cooperated in this cruising project by making available Assistant Ranger William Bryan. When office processing of the cruise data is completed this spring, plans are to start one of the stand variable treatments.

3. Watershed 41 was selected as an area for testing the influence on streamflow of converting and managing a forest stand to produce a maximum value of wood. This quarter the first conversion cut of 175,000 bd. ft. was marked, proposed roads located and laid out, specifications for removing forest products to retain water quality prepared, and a timber sale made to the Gordon Lumber Company of Asheville, North Carolina.

Hydrologic Notes

Air temperatures for the first quarter were below normal, and sub-freezing temperatures persisted for extended periods. For 30 days during the quarter the evaporation pan was frozen over with ice. A short warm period the last week of February and again during the second week in March advanced vegetative growth. A minimum of 7° on March 27 did considerable damage to pastures, flowering shrubs, fruit orchards and to forest trees where bud scales had broken and leaves had started to develop.

Table 1.--Climatic summary of air temperatures and evaporation

Month	Average		Maximum		Minimum		Evaporation	
	1955 of	Dev. from normal of	1955	Dev. from normal of	1955 of	Dev. from normal of	1955 in.	Dev. from normal in.
Jan.	36.8	-3.4	47.8	-3.3	25.7	-3.6	.95	--
Feb.	41.3	+0.3	52.9	-0.1	29.8	+0.9	1.77	+0.10
Mar.	49.6	+2.7	61.8	+1.9	37.5	+3.6	2.54	-0.28
Aver.	42.6	-0.1	54.2	-0.5	31.0	-0.7	1.75	--

A large portion of the January precipitation came in the form of snow. At the higher elevations snow accumulation was 10-12 inches and remained on the ground from January 15 to February 2. The precipitation deficit during the last 6 months in 1954 that had accumulated to 11.5 inches by late December influenced soil moisture and resultedin groundwater and streamflow being markedly below normal during the quarter. Due to lack of rainfall in January groundwater replenishment was slow. Streamflow did not respond materially during the February storms. It wasn't until after a 3-4 inch storm on March 22 that streamflow and groundwater elevations returned to normal spring levels. Since streamflow usually returns to these higher levels in December or January, this is one of the latest replenishment dates observed at Coweeta.

Table 2.--Precipitation summary

Month	1955	Dev. from normal
	Inches	Inches
January	2.35	-4.98
February	10.72	+3.86
March	6.67	-1.19
Quarterly total	19.61	-2.44
Water Yr. to 3/31	34.67	+0.91
Cal. Yr. to 3/31	19.61	-2.44

Cooperation

Universities:--There are 5 graduate theses scheduled for completion this spring. Since one member of the Coweeta staff is on each graduate committee it has kept Johnson and Kovner busy reviewing and commenting on analysis and contents of the first thesis drafts.

Leroy Jones' Masters Problem is handling the first conversion cut in placing a forest stand under intensive management to produce a maximum value of wood. His marking job was reviewed March 15 in a field conference with Forest Management people. The 175,000 bd.ft. of saw timber marked by Jones was sold to the Gordon Lumber Company of Asheville, North Carolina.

Professor Bob Dils from Michigan State College spent March 16-31 at Coweeta helping rewrite the "Outline for Compiling Precipitation and Runoff Data from Small Drainage Areas," Technical Note No. 34. Plans are to have the revised publication issued as a Station Paper during the coming summer.

Little Tennessee River Watershed Association:--Land owners and people living in the 90,000-acre watershed of the Little Tennessee River above Franklin, N. C., organized a mutual association February 27 with Dr. Harry Brown of Mountain City as President. The Association requested Forest Service help in assembling information and supplying research data that may be useful in developing its application for planning assistance. The Association has stated its objective for watershed improvement was to be through work on agricultural and forest land and will not stress use of engineering works to reduce flooding and siltation of streams.

Information and Education

Several news articles were prepared in response to requests for material on watershed management for the special Forestry Section of the Asheville Citizen-Times, February 27, 1955, commemorating the Golden Anniversary of the Forest Service.

A training session on water resource management was provided for the Assistant Supervisor and 5 District Rangers from the Cherokee National Forest and 7 Wildlife Specialists from the Tennessee Conservation Division.

Meginnis and Johnson spoke on research results of the Forest Service in the Eastern United States at a hydrologists training session of the Soil Conservation Service, Spartanburg, South Carolina, on January 4. These trainees are to be responsible for hydrologic evaluation in the small watershed program.

Johnson gave a talk, "The Water Shortage in North Carolina - Is There An Answer," at the February 10th Midwinter Board Meeting and Conservation Conference of the Garden Clubs of North Carolina, Inc. On March 22 he discussed the watershed management research program at Coweeta before members of the Hydraulic Data Branch, Tennessee Valley Authority.

Johnson spent February 11 at N. C. State College discussing Forest Influences with students and faculty members and lectured to XI Sigma Phi on Watershed Management Research of the Forest Service.

Visitors

Usually the first quarter of the year provides a breather from the heavy visitor schedule thus enabling the 2 technicians to get some research done. This quarter was one of the most active on record and we discussed our research program in the field to 12 groups totalling 115 people.

Publications

The publication, "A Method for Determining the Minimum Duration of Watershed Experiments," by Kovner and Evans was selected by the Committee on Runoff of the American Geophysical Union as an outstanding paper that has appeared in the current Transactions. The interest shown by the Committee members and in inquiries has led to the authors being requested to inform the American Geophysical Union about additional information and new developments they are making on this subject.

PIEDMONT RESEARCH CENTER

January - March 1955

Climate

The weather was fairly normal during January and February, but March did not conform. Rainfall during March was 2.41 inches below normal; however, the big calamity occurred when the temperature dropped below freezing the last five days of the month, killing the 1955 peach crop and severely damaging grain crops. The quarterly climatic summary is given in the following table.

Quarterly Climatic Summary - Calhoun Experimental Forest

Month	Average temperatures: Max.	Average temperatures: Min.	Average temperatures: Mean	Highest temp.	Lowest temp.	No. of days with rain	Precip.	Evap.
	°F	°F	°F	°F	°F		Inches	Inches
Jan.	53	28	40	75	14	9	4.31	1.74
Feb.	58	31	44	73	7	9	4.10	1.79
March	68	40	54	85	16	12	1.97	3.82

Stand Conversion Area

Much of the Piedmont forest occupies poor site. Most of this land is in its present condition due to effects of past land use practices on the soil. The question arises as to how fast and how much we can change the soil properties so as to improve growing conditions for vegetation. A long term project on the Calhoun Experimental Forest is aimed at this problem.

The general objective of the stand conversion study is to determine how species composition of forest stands will affect the physical characteristics of the soil and the incidence of the littleleaf disease of shortleaf pine.

Three areas of shortleaf pine, each about 10 acres in size and comparable as to site, are being managed so that the future stands will be shortleaf pine, a shortleaf pine-hardwood mixture, and ~~pine~~ hardwoods. Before any treatment was started the areas were mapped with respect to vegetation, littleleaf disease, Phytophthora cinnamomi occurrence, humus type and soil properties. Soil properties measured were confined to percolation rate, volume weight, pore space. Detailed soil maps were also made with respect to profile descriptions.

The treatment on the pine area has consisted of removing all hardwoods from the stand. Initially, all large hardwoods were poisoned, and since then all sprouts have been cut periodically. Open areas appearing in the stand are planted with shortleaf pine where natural seeding does not take place.

The treatment of the stand to be pine-hardwood has consisted of removing about half the overstory and planting both pine and hardwoods. Several thousand white oak, white ash and yellow-poplar have been planted to date. Some shortleaf pine has also been planted. Within the next four years the remainder of the old pine overstory will be removed and planting will continue until a good stand is assured.

On the area to be pure hardwood practically all of the pine overstory has been removed. Oak, ash and poplar have been planted throughout the area. In order to test the occurrence of littleleaf in the new stand some pine must be present and so about 10 percent of the new stand will consist of shortleaf pine.

The course of the littleleaf disease will be followed on the old pines on the pure pine area and on the new crop of pines on all three areas. Remeasurement of all other factors will be deferred until new stands are well established on the mixed and hardwood areas.

SEMI-ANNUAL REPORT
Forest Influences Research
Southern Forest Experiment Station

October 1954 - March 1955

Vicksburg Infiltration Project

Plans

A consultants' conference was held in Vicksburg December 8 and 9, 1954 to review soil-moisture prediction work conducted to date and to present current and proposed studies. Principal conclusions and recommendations agreed upon by the conferees are listed as follows:

1. The project should expand its study to humid tropical climates, with Puerto Rico recommended due to available Forest Service facilities, installations, and variety of soils and rainfall.

2. Emphasis should be placed on soils with trafficability problems; future studies should be directed toward improving the accuracy of the prediction at the high moisture contents; wells should be installed on wet sites for water table level observations.

3. Some data should be collected at Vicksburg toward comparison of accretion and depletion relations in plowed and non-plowed fields.

4. More data for frost conditions and spring breakup should be obtained.

5. It was emphasized that the work or correlation of prediction relations with soil and other site characteristics should be given very high priority. It was suggested that a statistician be employed to guide this work. It was recognized that this analysis of data might lead to the need for more field work.

6. The effects of temperature and latitude on rates of soil moisture depletion should be investigated further.

Consultants present were:

Dr. E. A. Colman, California Forest and Range Experiment Station, U. S. Forest Service, USDA, Berkeley, California.

Mr. M. D. Hoover, Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, USDA, Ft. Collins, Colorado.

Dr. G. W. Musgrave, Soil Conservation Service, USDA, Washington, D. C.

Mr. A. C. Orvedal, Soil Survey, SCS, Plant Industry Station, USDA, Beltsville, Maryland.

Dr. H. G. Wilm, New York College of Forestry, Syracuse, N. Y.

Dr. A. A. Warlam, Consulting Engineer, New York, N. Y.

Others in attendance at the conference in addition to members of the Project staff and Trafficability Section, Waterways Experiment Station staff were:

Mr. R. R. Phillipe, Office, Chief of Engineers, Department of the Army, Washington, D. C.

Mr. H. C. Storey, U. S. Forest Service, USDA, Washington, D. C.

Mr. L. R. Grosenbaugh, Southern Forest Experiment Station, U. S. Forest Service, USDA, New Orleans, Louisiana.

Mr. H. W. Lull, Northeastern Forest Experiment Station, U. S. Forest Service, USDA, Upper Darby, Pennsylvania.

Mr. M. P. Harrington, Bureau of Yards and Docks, U. S. Navy, Washington, D. C.

Mr. C. E. Molineaux, Cambridge Research Center, U. S. Air Force, Cambridge, Massachusetts.

Mr. P. Van Cauwenberg, Detroit Arsenal, Ordnance Corps, Department of the Army, Detroit, Michigan.

A field survey leaders meeting of the four regional survey parties was held in Vicksburg during the second week of January. The meeting was called to iron out various problems that had arisen, incorporate the pertinent recommendations of the consultants, and work out a uniform soil-moisture prediction procedure for use in the four regions.

Operations

An office report has been prepared on soil moisture and strength studies conducted in Alaska during last summer. Similar reports covering the studies at Miles City, Montana, and the Palouse area of Washington, have been prepared during the period.

The study on effect of solar radiation on soil-moisture drying was discontinued after having been in operation at Vicksburg since April, 1953. In this study three adjacent stacks of fiberglas units were

used for soil-moisture measurements, one stack under natural herbaceous cover, one with herbaceous cover clipped, and one kept bare of vegetation. In addition to the usual records of precipitation, air temperature, and relative humidity, measurements were made with Gier-Dunkle total and net-exchange radiometers, and Eppley pyrheliometer, and an evaporation pan with anemometer. Data are yet to be analyzed.

Preparatory to writing a work plan, soil, vegetation, and climate information has been collected for the tropical study scheduled to begin next fiscal year with headquarters in Puerto Rico. J. S. Horton and S. J. Knight of Waterways Experiment Station visited the Canal Zone, Jamaica, Haiti, Dominican Republic, and Puerto Rico making preliminary arrangements for the study.

The work of the soil strength-moisture surveys is progressing on schedule. The Southern Survey team is collecting soil moisture and strength data on 179 sites located in parts of seven states. The Northeastern Survey has established 138 sites in six states; the Lake States Survey is studying 169 sites in four states, and 144 sites are under study in three states of the Intermountain region. Detailed descriptions have been made of each of the 630 sites. Duplicate soil cores have been obtained at four depths for determinations of saturation volume, 60 cm. tension moisture, and bulk density. Several rounds have been made in measurement of soil moisture, cone index, and remolding index. Bulk samples were collected at three depths at each site and sent to Vicksburg for analysis. Organic matter and mechanical analysis have been completed on these 1,890 bulk samples, and plasticity constants determined on a portion of them. The Surveys have also been making soil moisture predictions for their sites using the procedures worked out at the Survey leaders meeting.

Work has continued periodically on analysis of soil moisture constants. Moisture constant data collected by the Project, and data obtained from recent literature have been compiled on cards. Low, intermediate, and high tension moisture values plus some field constants, are being correlated with other soil properties such as texture, organic matter, bulk density, big-pore volume, drainage capacity, and plastic limits.

A work plan has been prepared for the soil-moisture study of cultivated vs. non-cultivated areas. Initial smapling and site treatments have been made.

Results

The first two years work of the Project has been published in a 4-volume report consisting of some 600 pages. This was published as TM No. 3-331, Corps of Engineers, U. S. Army, entitled, "Forecasting Trafficability of Soils, Report No. 3, The Development of Methods for Predicting Soil Moisture Content," and dated October, 1954. It is not available for general distribution.

Also published in the last six months:

1. Reinhart, K. G. and Taylor, R. E.
   1954. Infiltration and available water storage capacity in the soil. Trans. Am. Geophys. Union 35: 791-795.

2. Reinhart, K. G. and Pierce, R. S.
   Dec. 1954. Tanks, trafficability, and trees. Southern Lumberman, 2 pp.

3. Moyle, Ralph C. and Zahner, Robert.
   Dec. 1954. Soil moisture as affected by stand condition. Southern Forest Experiment Station, Occasional Paper 137.

4. Carlson, Charles A. and Pierce, R. S.
   1955. The field maximum moisture content. Soil Sci. Soc. Am. Proc. 19: 81-83.

A paper, "Soil-moisture regime in some forest and non-forest sites in northern Wisconsin," by J. L. Thames, J. H. Stoeckeler, and R. A. Tobiaski, was presented at the 1954 meeting of Soil Sci. Soc. of America.

Publications in preparation include:

1. Waterways Experiment Station, Corps of Engineers.
   1955. Field tests of nuclear instruments for the measurement of soil moisture and density. Miscellaneous Paper No. 3-117.

2. Lull, H. W. and Reinhart, K. G.
   19--. Soil-moisture measurement. Planned as Occasional Paper, Southern Forest Experiment Station.

3. Carlson, C. A.
   19--. Estimation of field maximum moisture content. Probably will be sent to Soil Sci. Soc. Am. Proceedings.

A paper on the use of fiberglas units in mountain soils will be presented by J. S. Horton at the Western Snow Conference at Portland, Oregon in April, 1955.

Tallahatchie Research Center

Krilium Tests for Gully Planting

A study of the soil conditioning effects of Krilium on young loblolly pine planted on adverse gully sites was installed in May 1952 in north Mississippi. Krilium is a soil conditioner developed by the Monsanto Chemical Company for treating soils of high clay content to make them more porous and friable.

Results after three growing seasons since treatment strengthen earlier conclusions. On the basis of this test, Krilium offers little promise in gully and erosion-control planting on hard packed kaolinitic subsoils typical of north Mississippi gully bottoms. Its application to severely eroded sites is difficult and costly, and failed to improve survival or growth of loblolly seedlings on such adverse sites.

A manuscript presenting final results has been submitted for publication in the Journal of Forestry. The study has been closed.

Grasses and Legumes for Erosion Control

A study to determine the effects of selected grasses and legumes on soil hydrologic properties was established in north Mississippi in January 1955.

Three blocks were established in each of two borrow pits. Within each block ten treatments were planted. Each treatment is a selected grass or legume. Prior to being planted, the sites were examined to determine initial hydrologic conditions. As the treatments progress, the sites will be re-examined to determine the value of the different treatments.

Pine Response to Fertilizers

A study to determine the effects of single and repeated fertilizer applications on survival and growth of loblolly pine seedlings planted on severely eroded sites was established in April 1954.

The severe drouth conditions which prevailed through most of the growing season of 1954 eliminated the initial plantings on treatment and control areas alike. Replanting was completed during February and fertilization will be completed by April 1955.

Three replications each of six treatments were installed on eroded loess and on eroded Coastal Plain soil. Treatments included application of nitrogen, phosphorus, potassium, and trace elements singly and in various combinations. Early in 1956, a random half of each plot will again receive its original treatment.

Pine Response to Legumes

A study was installed in north Mississippi in April 1954 to determine the response of loblolly pine seedlings planted on adverse sites to interplanted herbaceous legumes.

These plantings failed almost completely during the severe drouth conditions of 1954. The study was re-established in February 1955.

Four replicated treatments were installed on sites of sheet eroded loess and of Coastal Plain soil. Loblolly seedlings planted 6 x 6 feet apart were interplanted with Lespedeza bicolor, Lespedeza sericea, and Trifolium incarnatum. A fourth set of plots without legume interplanting was included for controls.

Soil Moisture and Tree Growth

A cooperative study was installed in north Mississippi in April 1954 to determine the relationship between tree growth and soil moisture content as it varies from day to day and season to season, also to obtain soil and soil moisture data for the Forest Service Vicksburg Infiltration Project. Tree growth is measured by a dial gauge dendrometer and soil moisture by a Colman soil moisture meter.

Fiberglas units cover a range from the surface to 42 inches in depth on each of three loessial sites. The forest cover is 17-year-old shortleaf pine originally planted 6 x 6 feet.

During late June of 1954 soil moisture content neared the wilting point and tree growth leveled off quickly, then ceased. Slight growth was recorded during the winter months.

Soil moisture, climatic, and radial growth data will be gathered through the 1955 growing season.

Site Changes with Species Conversion

A study was installed in north Mississippi in March 1954 to determine the nature, rate, and extent of site changes--especially those affecting infiltration and retention of water--associated with conversion of ridge stands of worthless hardwoods to pine.

Treatments include three replications each of released loblolly seedlings planted at three spacings (4 x 4, 6 x 6, and 8 x 8) on each of three aspects (south, ridge, and north) plus controls. Despite drouth conditions, survival of planted seedlings on these forest soils has been excellent.

Changes in physical and chemical properties of the surface six inches related to watershed values, will be determined at intervals during the next 20 years. These properties include weight of surface litter, organic matter content, total pore space and size distribution, percolation rate, and bulk density.